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AUTOMOTIVE INDUSTRIES

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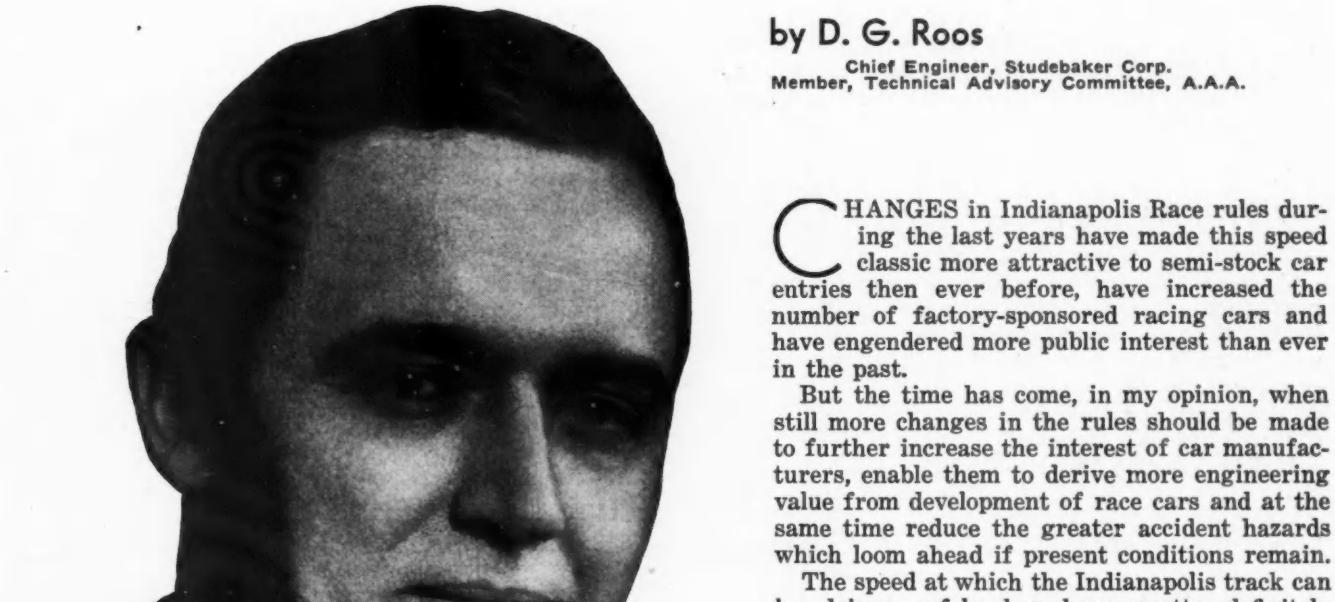
Let Engineering Rule the Roars at Indianapolis Speedway Classic

by D. G. Roos

Chief Engineer, Studebaker Corp.
Member, Technical Advisory Committee, A.A.A.



CHANGES in Indianapolis Race rules during the last years have made this speed classic more attractive to semi-stock car entries then ever before, have increased the number of factory-sponsored racing cars and have engendered more public interest than ever in the past.

But the time has come, in my opinion, when still more changes in the rules should be made to further increase the interest of car manufacturers, enable them to derive more engineering value from development of race cars and at the same time reduce the greater accident hazards which loom ahead if present conditions remain.

The speed at which the Indianapolis track can be driven safely has been pretty definitely reached. Unless some changes are made in the rules to lay some emphasis on factors other than speed alone, a series of accidents may occur in the future which might result in some outside influence being brought to bear to eliminate the race entirely.

Because of the peculiar conditions of the Indianapolis track, in other words, I believe that the manner of conducting the race from now on should not lay emphasis solely on

". . . oil limit . . . fuel limit . . . 600 miles . . . 32 cars . . ."

constantly increasing speeds. Otherwise, speeds will be increased without a doubt, designing abilities and tendencies being what they are. This doesn't mean that we should set up conditions designed to reduce the speed of the race, but merely that factors other than speed alone should be brought to the fore. It means only that the attempts to run the race at faster speeds should be tempered by other engineering considerations.

The fact that up until this year the race has been run without breaking the track record and still maintained a good attendance shows that a constantly increasing speed is not necessary to attract the public. The race as now constituted is being run fast enough for public interest and certainly fast enough for the safety of spectators and drivers.

On the basis of these facts, I submit the following suggestions for changes in the rules of the 1933 Indianapolis Race which, I believe, will introduce new elements of interest, make for greater safety, stimulate more valuable engineering developments and yet permit the race to be run at just as high speds as heretofore:

1. Limit the amount of oil used in the race cars to three gallons for 500 mile race.
2. Limit the amount of fuel to be used in the race cars to 11 gallons for every 100 miles.
3. Increase the length of the race from 500 to 600 miles.
4. Reduce from 40 to 32 the number of cars permitted in the race.

A few other possible modifications of existing rules seem to me desirable, but the four mentioned embody by far the most important possibilities for further improving the whole race both as a spectacle for the public to watch and as a source of actual engineering information.

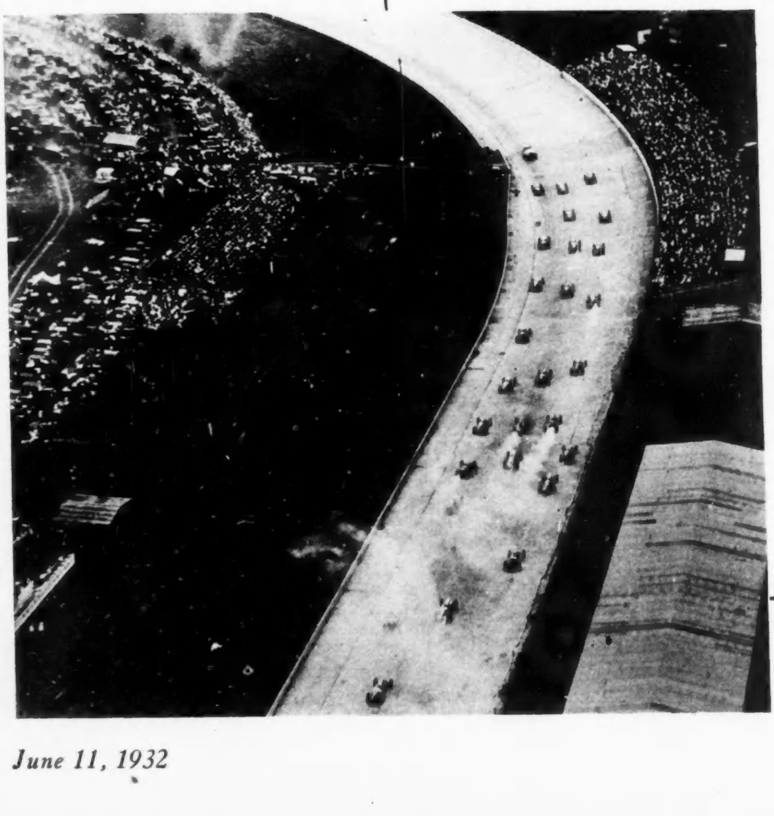
One of the great problems of the race has been to keep the track free of oil during the length of the race. Strangely enough, the simplest remedy to cure this trouble has never even been suggested, much less adopted, and that is, simply to limit the amount of lubricating oil which a car may use during the race.

If this were done, the oil piping connections and lubricating system would be gone over very thoroughly and, instead of putting the oil on the track, it would be kept in the engines. One of our cars ran 600 miles at an average speed of over 100 m.p.h. and used about 1½ quarts of oil during a test run on the Speedway just prior to the Decoration Day race this year.

Suppose we were to limit the amount of oil used in the race to 3 gal.—either contained in the crankcase or reserve—for the 500 miles next year. That is a generous amount. Later on, as experience proved further economies possible, this allowance could gradually be reduced—perhaps even cut in half. Actual racing conditions would be better, the oil would be kept off the track and very intensive technical and service thought would be focused on this particular element of design.

So with the limitation of gasoline consumption. The allowance suggested here might later be cut down somewhat, supposing the 11 gal. per 100 mile limitation were placed on the cars next year. Here, again, we would very definitely be stimulating real engineering development work which probably would be reflected immediately in stock car design throughout the industry. It would immediately result in more careful streamlining, because the surest way to reduce fuel consumption at these high speeds would be to reduce

Car Manufacturers Not Interested in Speed Alone



Automobile makers have revived their interest in the Memorial Day Sweepstakes because of the admission of semi-stock cars for the past two years.

The author believes a change in the rules will further encourage their activity in the race.

What do you think of his suggestions?

Write and tell us.

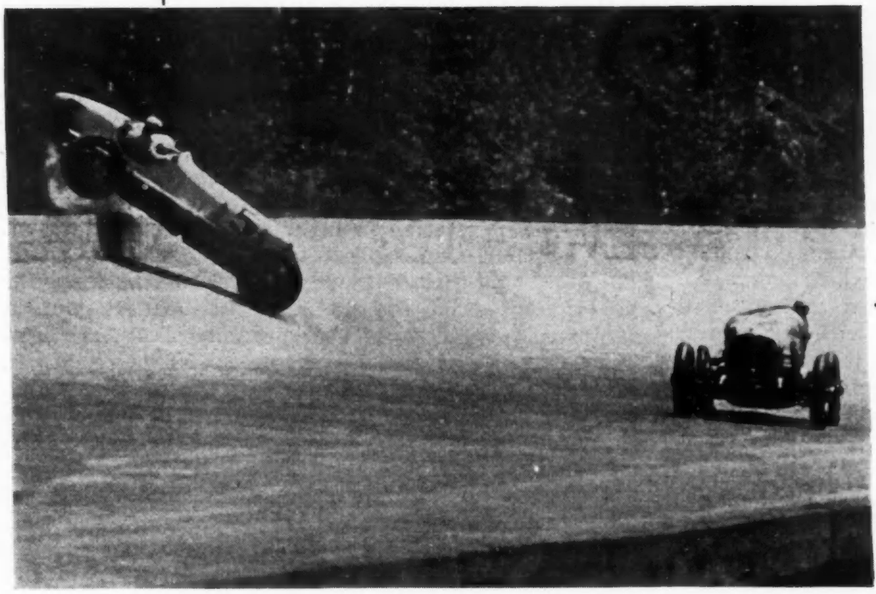
The Author

No one in the country, probably, is better qualified than D. G. Roos to suggest changes in Indianapolis Race rules to increase the value of the race to car manufacturers, its interest as a sporting event and its safety to drivers and spectators.

Certainly no one is better entitled to definite opinions on the subject.

Mr. Roos is a member of the National Technical Committee of the Contest Board of the A.A.A. and helped set up the rules under which the big Memorial Day race now is run. He is a vice-president of the Society of Automotive Engineers and a member of the Stock Car Contest Advisory Committee of that organization.

As chief engineer of Studebaker Corp. he participated actively in the design and testing of the five factory-sponsored Studebaker semi-stock models which ran so successfully at Indianapolis two weeks ago. Two of these cars, it will be recalled, were among the ten which finished the long grind; one of them placed third, breaking the previous track record at an average of 102.66 m.p.h. for the distance, the other sixth. Still another won thirteenth place, being flagged down with several other cars before completing the entire 500 miles.



Left: "... speed alone ... might result in elimination of the race entirely ..."

Billy Arnold, intrepid driver, hurtling over the north wall in the recent race. He swerved to miss hitting the car ahead, which went into a skid.

head resistance. It would put a premium of getting proper balance between engine displacement, rear axle ratio, wheel diameter, car weight and head resistance, all of which have to be properly related to obtain top speed and to be able to run a given distance on a given fuel allowance.

Certain other detailed rule changes might be necessary, I realize, to make the race effective under these new conditions, but I think they can be taken care of by advance study and analysis. A rule might be needed, for instance, to prevent drivers loafing around the track to get good gasoline mileage, but the competitive element probably would take care of this. If the fuel were cut down so far that any or all of the cars couldn't go the distance, then it might be ruled that the car leading at, say, 450 miles, won the race, but that if any car completed the distance at a certain minimum speed, say 95 m.p.h., that car would be the winner. But, again, I don't think such a contingency need arise, since the fuel limitation matter can be approached gradually and on a sound statistical basis by a committee of engineers.

The number of starters should be reduced in the interests of safety. During the first ten or fifteen laps we have a huge bunch of cars driving at extremely high speeds and the probability of serious accident increases with the number of cars involved. The increase in number of starters probably was made because of the fear that with the 91 cu. in. jobs so many would drop out from mechanical failures as to leave only cripples on the track and make an uninteresting finish.

That condition no longer exists. Enough semi-stock cars are now in the race to insure a goodly number of finishers—and good finishers. Moreover the new specifications have produced from the strictly racing car designers, vehicles much less sensitive and much more durable than the old 91 cu. in. jobs. The number of entries should be reduced from 40 to 32.

Mr. Meyers, manager of the Speedway, feels that the 500 mile distance is traditional and should not be changed. He may be right, but I think a 600 mile race would benefit all concerned. It would help to take the emphasis away from sheer speed. And it would show up weaknesses in tires and chassis to a greater extent. Relief drivers at the end of 300 miles could be arranged if necessary.

Moreover, the longer race would give impetus to conservative driving—the necessity of staying in. That would mean that the leaders wouldn't be afraid to make a pit stop for inspection if something seemed about to go wrong, as they could make such a stop and still not lose all chance of winning the race.

While I haven't discussed this question yet with all the chief engineers of other passenger car companies,

(*Turn to page 870, please*)

PV Factor is NOT

by P. M. Heldt

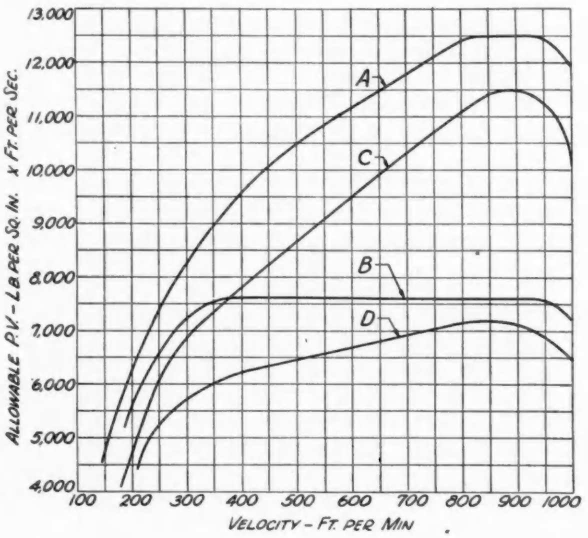


Fig. 1 — Relation between maximum allowable PV and the sliding velocity for different bearing materials

ENGINE manufacturers in recent years have experienced serious trouble with crankshaft bearings. The loads to which engine bearings are subjected increase rapidly with the speed, and speeds have been rising constantly. Moreover, with the tendency toward increased cylinder numbers, it is necessary to limit the lengths of individual bearings, so that the overall length of the engine will not become too great, and it is therefore impossible to provide for the increased load due to the increase in speed by increasing bearing lengths proportionately. The result is that unit pressures on the projected bearing areas have increased sharply, and a close approach has been made to the limit of safety—in some cases too close an approach. The general adoption of pressure lubrication and the introduction of oil coolers in recent years bear witness to the increasing difficulties of bearing lubrication.

The two most important factors in the life of bearings—aside from the lubricant used, regarding which the manufacturer can only make recommendations—are the unit pressure or unit load on the projected area of the bearing, and the surface velocity or rubbing speed. In recent discussions of the subject of bearing capacity there has been frequent reference to the *PV* factor, and it seems to be the impression of some engineers that any bearing has a definite *PV* capacity.

The usual cause of bearing failure is too high a temperature, due to too great frictional loss in the bearing, for the quality of lubricant used, the physical condition of the bearing surfaces, and the materials of which the bearings are made. If the limiting capacity of a bearing could be expressed accurately in terms of *PV*, it would imply that *P* and *V* had equal effects on the degree of loading or on the factor of safety of the bearing, so that if *V* were doubled, for instance, it would be necessary to halve *P* in order to retain the same factor of safety.

The impression that bearing capacity can be expressed in terms of *PV* is evidently based on the assumption that the friction coefficient of an engine bearing is a constant factor. With a constant coefficient of friction, the heat generated in the bearing would be directly proportional to the load and to the rubbing speed. Since any given bearing has a definite capacity for getting rid of heat, if the coefficient of friction were constant, and the friction therefore directly proportional to the load, the product of unit load *P* (in pounds per square inch of projected area) into the rubbing speed (in feet per minute) would have to be kept within a definite limit if the bearing were not to overheat and score or seize. In well-lubricated bearings, however, like those of an engine crankshaft in normal operation, the coefficient of friction is not constant. On the contrary the friction is practically independent of the load, which means that the coefficient of friction is inversely proportional to the load. The friction coefficient increases with the speed, however, and though there is a relation between the rubbing speed and the maximum safe load, it is of an indirect character. As the speed increases, the heat generated in the bearing increases. This results in an increase in the temperature of the oil film which supports the journal. With an increase in temperature the viscosity of the oil decreases, and the less viscous oil will not sustain so great a load.

Granting that there is a maximum oil-film temperature which cannot be exceeded with safety, and that when at this temperature the bearing disperses heat at a definite rate, it follows that as the speed of the journal is increased, the unit load on the bearing must be decreased; but the relation between the increase in speed and the decrease in the maximum safe load involves the relations between the rate of heat generation in the bearing and the temperature rise of the oil film, and between the temperature and viscosity of the oil; and the relation between the rubbing speed and the maximum safe specific load therefore cannot be clothed in any simple algebraic equation.

The problem here under discussion bears a certain resemblance to that of engine horsepower rating, which it is often attempted to base on the cylinder dimensions alone. In both cases the two principal factors involved affect the result differently; and besides, in each case there are several other factors entering in, so that any equation based on the two most important factors can be only approximate.

That unit load and rubbing speed affect bearing capacity differently is well illustrated by some curves given by Alex Taub in his paper on Engine Bearings From the Designer's Viewpoint, presented at the last annual meeting of the S.A.E., which curves are based on experimental results obtained in the laboratory of the Bunting Brass & Bronze Co. One of these curve sheets is reproduced herewith. In this the limiting *PV* values are plotted against the rubbing velocity *V*

Proper Measure of Bearing Capacity

Heat losses, for example, vary with velocity but not with pressure, says Mr. Heldt, in this lucid analysis of a troublesome problem. As velocity is increased, the maximum permissible unit-load decreases, because the greater loss results in a higher oil temperature and lower oil viscosity, and thinner oil will not sustain so high a unit-load

in ft. per minute. Similar curves were given in which the *PV* values were plotted against the unit load on the bearing in lb. p. sq. in. If both unit load and rubbing velocity had the same effect on the factor of safety of the bearing, all of the graphs should be straight horizontal lines, while in reality the limiting *PV* values in a general way increase with the rubbing speed but decrease as the specific load increases.

The irregular form of some of the curves shows, moreover, that the relation between *V* and the corresponding maximum *P* is not governed by any simple law which holds throughout the range of the factors covered by the curves. The sharp deviations at certain points indicate clearly that new factors become effective at these points. If we take a limited range of the variables they can be made to fit a simple equation quite closely. For instance, the experimental values obtained with the *A* bronze (Fig. 1) all lie remarkably close to the curve whose equation is

$$(P/100)^3(V/1000)^2 = 373$$

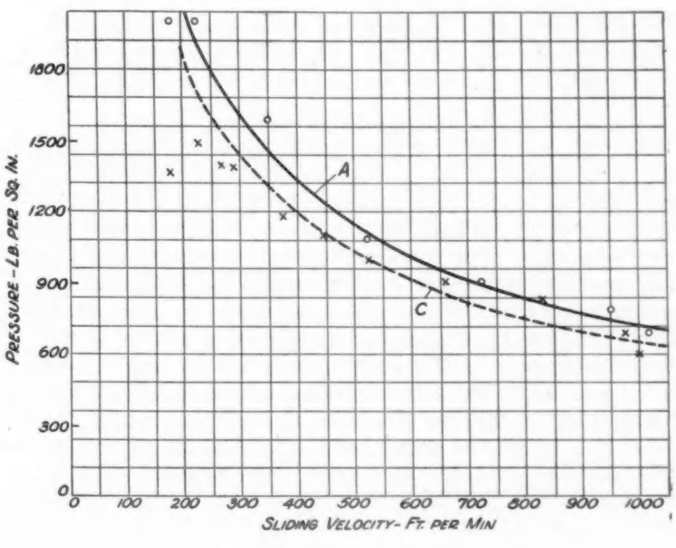
as shown by the full-line curve and the observation points marked by small circles in Fig. 2. About the best equation of this type that can be found for the data obtained from the *C* bronze is

$$(P/100)^3(V/1000)^2 = 267$$

as shown by the dotted line and crosses marking observation points in Fig. 2. It will be noted, however, that in the latter case the observation points representing low values of *V* are rather far off the curve, and it is obvious that some other form of equation would fit the data better. That the data for the *A* bronze conform so well to the equation cited is evidently due to a coincidence, and it must not be assumed that the equation represents a natural law. The form of the equation shows, however, that the sliding velocity has a greater influence on the phenomena resulting in bearing failure, viz., overheating, than has the unit load carried.

The relation between crankshaft speed and the temperature of the oil in the crankpin bearing has been determined experimentally by C. G. Williams, who discussed his results in a recent issue of *Engineering* of London. A single-cylinder "dummy" engine was "motored" at different speeds, and with the aid of a thermocouple the temperature was measured as close to the bearing surface as possible. The temperature of the bearing naturally varied with the temperature of the air in the crankcase, and in Fig. 3 the temperatures of the crankpin bearing are plotted as functions of the crankcase-air temperatures for different crankshaft speeds. With a crankcase-air temperature of 104 deg. F. the bearing temperature was 104 deg. F. at 1000 r.p.m. and 153 deg. F. at 4000 r.p.m. Mr. Williams observes that the importance of crankcase-air temperatures is realized only when the values of the expression ZN/P (which are proportional to the coefficient of friction) are plotted against speed for the different crankcase-air temperatures. In this expression Z represents the kinematic viscosity of the oil in centipoises; N, the speed in revolutions per minute, and P, the specific pressure in pounds per square inch of projected area. According to some experimental evidence at hand, the minimum value of ZN/P for a well-run-in bearing is 30, and an increase in the speed of the crankshaft reduced the value of ZN/P from 510 to 60, and the factor of safety therefore from 17 to 2. By decreasing the temperature of the air in the crankcase from 149 to

Fig. 2—Relation between maximum allowable unit bearing load and sliding velocity for two bearing metals



104 deg. F., the factor of safety at 3000 r.p.m. was increased from 2 to 8. These figures are based upon the temperature-viscosity curve of the particular oil used in the experiments. Probably the best way to control the temperature of the crankcase air is by means of an oil cooler, which latter therefore constitutes a powerful means of increasing bearing capacity.

Aside from the influence of the temperature-viscosity relation of the oil on the relation between rubbing speed and load capacity, the effect of distortion of the bearing and its support must be considered. In theoretical discussions it is always assumed that the load is uniformly distributed over the entire bearing surface, which presupposes that the axis of the journal is absolutely parallel with the axis of the bearing. In practice this practically never holds. Owing to the properties of the oil film, even a slight deviation from parallelism of the axes results in a very non-uniform distribution of the load on the bearing.

Distortion of the crankshaft and consequent unequal bearing of the journals was a frequent cause of failure in early automobile engines. The desirability of a low rubbing speed was fully understood at the time, and to keep rubbing speeds down, small journal diameters were used. But the use of such flimsy crankshafts gave rise to abnormal deflections and consequent concentration of the loads on a small fraction of the bearing surfaces. When this defect was recognized and crankshafts were increased in diameter, it was found that even though the rubbing speeds were higher, the bearing would carry a greater unit load than previously. What determines bearing failure, of course, is not the mean load on the bearing surface, but the maximum specific load on any part of it.

Shaft distortion in automobile engines can be materially reduced by the use of crankshaft counterweights. Mr. Taub in his paper pointed out that these counterweights help with the bearing problem in two ways. In the first place, they reduce the load on the bearing, and secondly, they reduce shaft deflection, thus assuring a more nearly uniform distribution of the load over the whole of the bearing surface and keeping down the maximum specific load. Counterweights do not affect the load on the crankpin bearing. The load on this bearing can be reduced only by lightening the reciprocating parts, including the pistons and connecting rods. A reduction in the weight of reciprocating parts reduces the loads on the main bearing also, but in their case the same result can be achieved at less cost by providing the crankshaft with counterweights.

Since it is the oil film that supports the load, no doubt the method of introducing and distributing the oil in the bearing has an influence on the capacity for supporting load. The pressure in the oil film cannot be great near the edge of the bearing surface, and for any great pressure to be built up it is necessary that the surface should not be broken up too much by oil grooves. At the same time, provision must be made to get the oil to all parts of the bearing continuously, for if any part of the bearing surface is deprived of oil it no longer helps to sustain the load. In bearings supporting a unidirectional load it is customary to feed the oil on the non-loaded side, but in all engine bearings the load travels around continuously, and no matter where the inlet and the grooves are located, they will be at the maximum-loaded part once every revolution. It is different if the oil is delivered to the bearing through the shaft.

From experimental data developed by the Bunting Brass & Bronze Company it appears that the load under

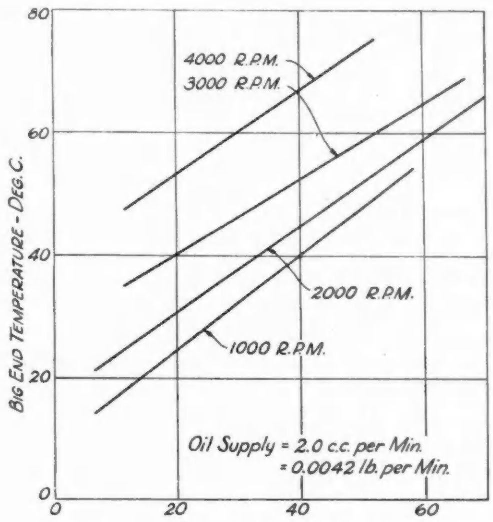


Fig. 3—Effect of crank-case-air temperature on temperature of crankpin bearing

which a bearing fails depends to a large extent upon the material of the bearing surface. As long as there is a continuous film, the material of the bearing is a matter of little consequence, but, of course, every failure is preceded by metal-to-metal contact, and the composition of the bearing material naturally has much to do with what happens when such contact occurs. In complete film lubrication the sliding motion at the bearing surface is entirely between different layers of oil molecules, but as the film is being broken, the oil molecules are removed from the molecules of the surface metal to which they adhere, and evidently the adherence between the bearing metal and the oil plays a part in the limiting bearing capacity. If the adhesion between the bearing metal and the oil is high, the film will not so easily be broken and the capacity of the bearing will be greater.

The mechanical properties of the bearing metal also have an effect on the bearing capacity. Some of the white metals lose considerably in mechanical strength at the temperatures reached in bearings under the most severe operating conditions, while others are more resistant to the effects of high temperatures.

Experimental results as well as regular practice show that for a given rubbing velocity the unit load which a bearing will withstand is greater with force-feed than with drip lubrication. This may be at least partly accounted for by the fact that with force feed the oil passes through the bearing at a much more rapid rate, and the oil circulation helps to cool the bearing more effectively, hence the oil in the film does not reach so high a temperature, and its viscosity does not drop so low.

Increased trouble from bearing failure has renewed interest in methods for calculating bearing loads. The methods in use so far, in accordance with which the bearing load under full engine load is calculated for 24 equally spaced points of the cycle, are rather tedious, and simplifications of this method are desirable.

One question that arises in this connection is whether the capacity of the bearing is dependent mainly upon the maximum or the mean bearing load during the cycle. If it is mainly dependent on the former, then there is no need for calculating the bearing loads for 24 points of the cycle. Throughout the range of full-film lubrication the heat generated in the bearing does not increase with the bearing load, and it might be thought that what determines the disruption of the oil film is the maximum pressure at any point of the cycle. However, this maximum pressure persists for a brief moment only, and it is not at all certain whether the factor of safety is more dependent upon it or on the mean pressure.

The argument has been raised in this connection that the theory of complete film lubrication is of little interest to the bearing designer, as a bearing never fails when it has complete film lubrication. Every bearing failure is preceded by rupture of the oil film, and therefore by operating conditions which are entirely different from those of complete film lubrication. The writer cannot see any logic in this argument, however. In the great majority of cases bearing failure occurs as the result of abnormal operating conditions—excessive dilution of crankcase lubricant, extreme atmospheric temperature, excessively hard driving, etc. These abnormal conditions can be allowed for in design calculations in no other way than by a factor of safety. The bearing is calculated for normal operating conditions, under which there is always complete film lubrication, and the factor of safety takes care of the abnormal conditions, which can never be definitely known.

The minimum value of ZN/P (which corresponds to the elastic limit in mechanical tests) can be determined experimentally for any bearing material and any system of lubrication. It would also be necessary to set reasonable limits for the temperature and the degree of dilution of the crankcase oil, and to then determine the kinematic viscosity of the diluted oil at the maximum temperature decided upon. The values of the maximum engine speed and the maximum unit loads on bearings can be calculated with tolerable accuracy by well-known methods, and with the minimum value of ZN/P determined experimentally for the particular bearing material and method of lubrication, it should be possible to predetermine the factor of safety of the bearing with a satisfactory degree of accuracy.

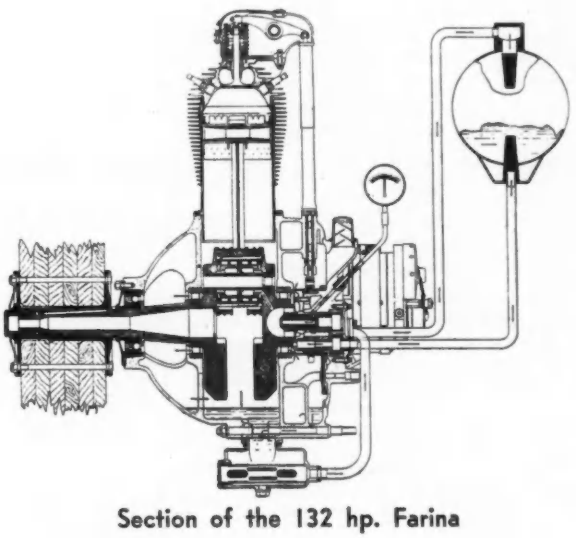
Connecting Rods of Farina Radial Are of Equal Length

A FIVE-CYLINDER, radial, air-cooled engine, recently developed by the Italian firm Stabilimenti Farina, has five equal connecting rods which are sector-shaped at their big ends, these big-end sectors being against a bronze sleeve with their inner sides and against two bearing-metal lined rings with their outsides.

As contrasted with the conventional arrangement of one master rod and a number of link rods, this construction has the advantage that all connecting rods are interchangeable and therefore can be produced somewhat more cheaply; and that the strokes of all pistons are equal and equally timed, so that the primary unbalanced forces can be completely balanced by suitable counterweights on the crank arms.

There is only very slight motion between the sectors on the connecting rod head and the interior and exterior bearings, which is due to the change in the angle between the shanks of connecting rods of adjacent cylinders moves from a position midway between the two cylinder axes and close to the position diametrically opposite thereto.

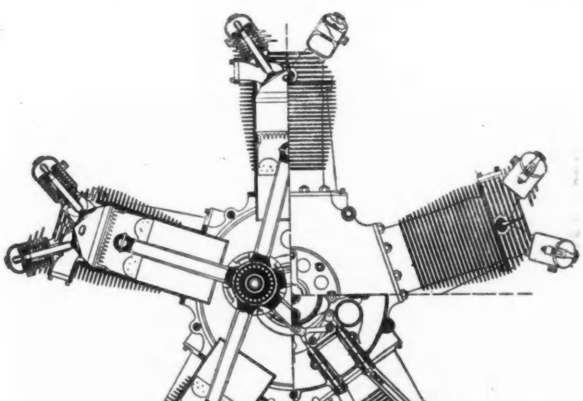
To allow for this motion each sector must be made to embrace less than one-fifth of the circumference. Within the inner bearing bushing there is a roller bearing mounted on the crankpin, and most of the motion between the connecting rod heads and the crankpin is in this bearing.



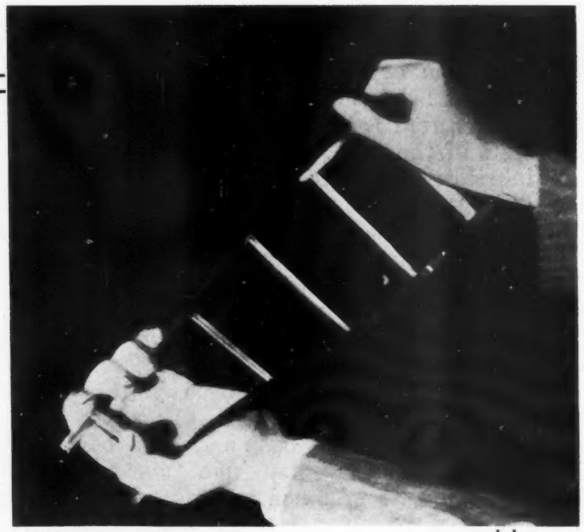
Section of the 132 hp. Farina

Cylinder dimensions are 120 x 142 mm. (4.71 x 5.59 in.), which gives a displacement of 488 cu. in. With a compression ratio of 5.4 the engine develops a maximum torque of 372 lb.-ft., the brake mean effective pressure being 142 lb. per sq. in. The output, according to the international rating rules, is 132 hp. at 1800 r.p.m.

The overall diameter is 41⅜ in. and the weight of the engine is 317 lb., or 2.4 lb. per hp. The engine is designed chiefly for use in training planes.



Master and Link rods of the Italian Farina engine



Chilton Staff Photo

"X" Frames Six Times Stiffer, Tests Show

by Joseph Geschelin

RIGID or flexible? That's the question. And it has been going the rounds in engineering circles since chassis and bodies have been built.

No matter what side of the fence you're on, whether you think the frame or the body should take the load, or both, the fact is that a majority of car makers mounted their 1932 creations on as rigid a frame as one with X-members can be expected to be. The latest report is that the new Fiat 508 has followed the lead, although the reaction overseas is still a matter of conjecture.

How rigid? What is the relative rigidity of different designs? These questions arise immediately and should be answered before a design goes to the shop. One simple and relatively inexpensive method is provided by studying faithful scale models as described in this article.

Last week [1] we showed the use of a scale model in developing an Autogiro fuselage. Now we describe a simple method of studying the dynamic similarity of a chassis frame with lateral cross-members and one representative of current X-frame construction. This analysis may be carried further to compare different types of X-frames, the effect of variations in the disposition of cross-members, as well as the possibility of weight reduction.

Figs. 1 and 2 show the frames used in this study. Both are accurate scale models carefully welded at the joints. When brought down to scale, the frame in Fig. 2 is so flexible that it is readily twisted by hand; the other takes much more effort. The method of testing was to constrain the frame at three corners and to load the free end. Deflections and loads were accurately measured and recorded. The results are shown graphically in Fig. 3.

For simplicity let us use the following notation:

Frame A—Fig. 1
Frame B—Fig. 2
d_A —Deflection for frame A
d_B —Deflection for frame B
W_A —Weight of frame A=311 grams
W_B —Weight of frame B=230 grams

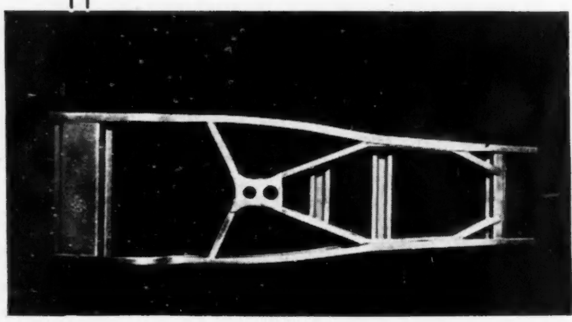
At a load of 17 lb. which is the maximum carried by frame B, d_A = 3/16 in.; d_B = 1 7/16 in. Note in this connection that both frames assumed a slight permanent set under the load conditions of Fig. 3. Now since rigidity is inversely proportional to deflection, the rigidity of frame A as compared with B is 17/3 or 6 to 1 roughly. Carrying the comparison further, we find that frame A is 35 per cent heavier than B. But it has six times the torsional rigidity.

Given ordinary facilities, the investigation could be carried much further. For example, one could study the possibilities of weight reduction and the consequent

(Turn to page 868, please)

[1] "Kellett Solves Autogiro Structural Problems," by Joseph Geschelin, *Automotive Industries*, June 4, 1932.

Fig. 1—Chassis frame with X-member construction following 1932 practice



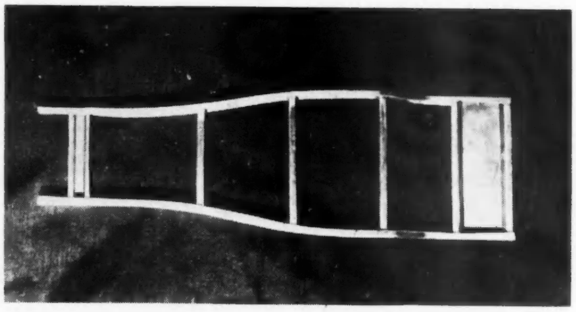


Fig. 2—Model of conventional chassis with lateral cross-members

Just Among Ourselves

Wax Dummies Take the Fire

WHEN announcing his new floating power models, Citroen—so the story goes—placed a number of wax dummies on the floor of his Paris showrooms. He dressed them in the height of masculine fashion and opened the doors to the public.

During each of the ensuing days visitors were found cautiously approaching the dummies and deferentially inquiring the price of the new cars.

Now, this yarn comes to us by way of Detroit where automobile factory executives abound. That being the case, need we add the inevitable comment which came with it? We think not. We are certain that you have guessed it. Yes, that's right; the comment was:

"The idea might work out well in the showrooms in this country. At least the *completely* silent salesman wouldn't get a salary or drawing account every week!"

"Sprechen Ist Silbern"—But it Tarnishes

AN automobile dealer in Plymouth, Pa., has been operating a radio and loud speaker continuously since Aug. 27, 1930. His name is J. E. Piszcek and he runs the Cauly Motor Co. He writes us to find out if anybody else is making such an endurance test and whether or not he probably is justified in claiming the marathon radio-playing championship or something like that.

Our official answer was that we know of no other such endurance contest being conducted. Unofficially we might add the prayer that none ever will be conducted within 100 miles of any place we have to live or work. Properly used, the radio may be a business attracter in retail stores. Improperly and raucously continued, as it frequently is, it is a goat-getter *par excellence*. If we must have marathon contests, we favor confining them to quiet things like dancing and tree-sitting.

Old Latin Tag Applies to Cars

THE automobiles with the most striking bodies have done better this year relatively than have the more conservatively designed vehicles. It may seem trite to make this statement, but its great importance shouldn't be missed.

Sales aren't really good for anybody in 1932. Nevertheless outstanding bodies have put several companies in relatively better positions than they were before. We don't need to name the cars. You know them. When these now successful body lines first came out, we heard them criticized plenty by rival manufacturers. Some laymen disliked them, also. But they went over.

Too often manufacturers belittle radical designs announced by competitors, lend an ear only to such unfavorable comment as they hear from the public and permit the wish to be the father to the thought with detriment to themselves. Finally they permit themselves to become convinced.

That's what's been happening this year, at any rate, we believe. There are strong indications that 1933 models will see some striking body jobs on cars which heretofore have been noted for relative conservatism. And some of them *may* be out before the end of the summer.

That will be good news for the die and tool fellows anyhow!

Retail Car Financing Stretching to 18 Months

DEFINITE evidence of longer retail financing terms is beginning to appear. Eighteen months paper, while not at all uncommon during the last year or two, has been frowned upon to some extent nevertheless. Now it seems to be taking its place as a regular rather than an irregular part of financing practice.

Increases in rates have already been made by one or two of the larger finance companies and it would not be surprising were others to follow. The increases are laid to higher cost of doing business brought about by decreased volume and desire to keep reserves up. Some observers see a relation between the increased rates and the longer terms being offered, pointing to higher repossession losses as a likely concomitant of 18 as compared to 12 months paper.

Offsetting this, of course, is determination on the part of the finance companies offering these longer terms to tighten up on down payments and examine individual credit risks even more carefully than in the past.

An executive of one of the largest companies said just the other day that, "This is the tough spot of the depression for the finance companies." He was probably right.

Merely an Indication?

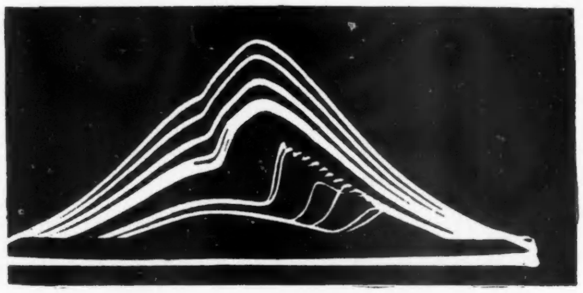
A CAR distributor in a Southern city the other day was talking of the generally depressed condition of the trade and the difficulties of individual car accounts in the city. "The Blank distributor is in bad shape," he said, shaking his head. "In my opinion he's just about washed up. . . . . In fact, he shot himself last week!"—N.G.S.

Table I

Factor	Condition	Diesel Engine	Carburetor Engine
Compression ratio	low	Pro-Knock	Anti-Knock
	high	Anti-Knock	Pro-Knock
Intake air temp.	low	Pro-Knock	Anti-Knock
	high	Anti-Knock	Pro-Knock
Cylinder head temp.	low	Pro-Knock	Anti-Knock
	high	Anti-Knock	Pro-Knock
Fuels	Saturated hydrocarbons, saturated paraffins:	Anti-Knock	Anti-Knock
	Unsat. hydrocarbons: aromatics, naphthenes	Pro-Knock	Pro-Knock
Dopes	Tetraethyl lead, Benzol	Anti-Knock	Anti-Knock
	Amylnitrate, benzaldehyde, acetaldehyde	Anti-Knock	Pro-Knock
Intake air density	low (throttling)	Pro-Knock	Anti-Knock
	high (supercharging)	Anti-Knock	Pro-Knock
Injection (spark)	advance	Pro-Knock	Pro-Knock
	retard	Anti-Knock	Anti-Knock

Diesels Reverse

Fig. 1 — Showing that rate of pressure rise increases as the maximum pressure is decreased by throttling



IN a paper entitled "Combustion Knock in Diesel Engines," presented at the Penn State Oil-Power Conference on June 8, the author, Dr. P. H. Schweitzer, associate professor of engineering research at Pennsylvania State College, called attention to the rather singular fact that practically every factor which tends to aggravate knocking in spark-ignition engines tends to suppress it in Diesel engines. For instance, a high compression ratio is generally regarded as the primary cause of gasoline-engine knock, while Ricardo has established the fact that in a Diesel engine, knock can be cured by increasing the compression. Tetraethyl lead is a very effective anti-knock for gasoline engines, and an equally powerful pro-knock for Diesel engines. Further, fuels of paraffin base, consisting chiefly of saturated "straight-chain" hydrocarbons, are the worst knocking fuels in carburetor engines, but they give rather smooth combustion in Diesel engines. Benzol, which is one of the best anti-knock fuels for gasoline engines, will not burn smoothly in Diesel engines at all. Knocking in a gasoline engine can be suppressed by throttling the charge, while in a Diesel engine the same result can be achieved by supercharging. Following is an abstract of Dr. Schweitzer's paper.

A study of large, accurate indicator cards has led to the conclusion that in both types of engine, knock is attended by a very rapid rise of the cylinder pressure. While the critical rate varies somewhat with the cylinder size and other factors, an engine ordinarily operates smoothly if the pressure rise is less than 30 lb. p. sq. in. per deg. of crank motion, and knocks if it exceeds 50 lb. p. sq. in. per deg. It is also fairly well established that in both engine types detonation is preceded by autoignition of a portion of the combustible charge in the cylinder.

Whereas in the spark-ignition engine it is the last portion of the charge to burn that causes the knock, in the Diesel engine combustion begins with autoignition, the intended method. Self-ignition, however, does not necessarily cause detonation, as is evidenced by the performance of thousands of smooth-running Diesel engines. The determining factor is how much of the fuel ignites simultaneously. The greater the quantity of fuel in the cylinder that ignites practically simultaneously, the more rapid the pressure rise, and the more intense the knock.

It is often assumed that the fuel is ignited instantly upon its entrance to the cylinder, but such is not the case; if it were, then it would be possible to control the rate of pressure rise by means of the rate of fuel injection. Injection usually extends over at least 20 deg. of crank motion, and with a compression pressure of 450 lb. p. sq. in. a maximum pressure of 1000 lb. p. sq. in. could be reached during this period with no greater rate of pressure rise than 27.5 lb. p. sq. in. per degree, which, it will be noted, is within the smooth-operating limit. But the phenomenon of ignition lag interferes with this control.

The injected fuel does not ignite instantaneously,

Knocking Behavior of Carbureted Engines

Dr. P. H. Schweitzer summarizes the experience with both types of engines, in a paper at the Oil and Gas Power Conference of the A.S.M.E., concluding that virtually every factor which tends to aggravate knocking in spark-ignition types tends to suppress it in Diesel engines

but only after a delay period varying normally between 0.001 and 0.004 sec., which time is required to heat the most easily ignited portion of the fuel charge to its ignition temperature. This delay results in a certain amount of fuel accumulating in the cylinder before any of it is ignited. For instance, at 1000 r.p.m. a delay of 0.002 sec. corresponds to 12 deg. of crank motion, and if the rate of fuel delivery is uniform through a 20-deg. injection period, more than half of the fuel is in the cylinder when ignition occurs. Nearly all of this fuel becomes ignited simultaneously, and as a result there is a violent pressure rise with an audible knock. The greater the ignition lag, the higher the maximum rate of pressure rise and the more severe the knock. Rothrock found a linear relation to exist between the maximum rate of pressure rise and the ignition lag.

Although a high maximum pressure is often associated with knock, this is not necessarily the case, as shown by Boerlage and Broeze, who by throttling the intake stepwise obtained louder and louder knocks, and indicator cards (Fig. 1) showed that although the maximum pressure decreased with the degree of throttling, the maximum rate of pressure rise increased.

In a Diesel engine it is, as a rule, the first part of the fuel to burn—that injected during the period of ignition lag—which causes the knock. The portion injected last burns as soon as it leaves the spray nozzle, and its combustion can be controlled. This explains the divergent behaviors of the gasoline and Diesel engines. All factors in Table I which reduce ignition lag are therefore anti-knocks in a Diesel engine. The ignition lag depends primarily on the difference between the air temperature and the self-ignition temperature of the fuel. The higher the former and the lower the latter, the smaller will be the lag. A high compression ratio, a high inlet-air temperature and a high jacket temperature all increase the temperature of the air at the end of compression and reduce the ignition lag. A higher air density due to supercharging has the effect of promoting the transfer of heat from the air to the fuel, and therefore also reduces the ignition lag. Turbulence of the hot air has a similar effect. The same factors, by speeding up the combustion, in-

Table II—Properties of 14 Diesel Fuels

Fuel No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sp. Gr. at 60° F	0.867	0.870	0.877	0.896	0.833	0.852	0.867	0.855	0.896	0.904	0.910	0.929	0.978	0.793
Flash Point (P.M.) °F	236	226	220	190	182	188	184	208	184	206	202	178	128	102
Set Point °F	8	12	22	37	12	-20	—20	-10	-20	-20	-20	-2	-20	-89
Kinematic Viscosity at 100° F	.0520	.0735	.0987	.2318	.0295	.0307	.0403	.0396	.0412	.0412	.1407	.1014	0520	——
Calorific Value Gross B.T.U.'s/lb.	19,500	19,450	19,390	19,280	19,700	19,800	19,700	19,675	19,300	19,150	19,220	19,250	16,800	20,040
Net B.T.U.'s/lb	18,290	18,250	18,200	18,100	18,460	18,600	18,490	18,460	18,170	18,050	18,080	18,170	15,940	18,720
Sediment %	.003	.004	.006	.008	.007	.009	.007	.008	.002	trace	.011	.016	.126	nil
Ash %	.001	.001	.003	.005	.003	.004	.003	.003	trace	trace	.003	.006	.021	nil
C %	85.60	85.58	85.56	85.51	85.61	85.69	86.50	85.41	86.88	86.80	85.63	87.62	82.05	—
H %	12.69	12.60	12.53	12.38	13.03	12.65	12.77	12.82	11.88	11.63	12.02	11.40	9.05	—
C/H Ratio	6.7	6.8	6.8	6.8	6.6	6.8	6.8	6.7	7.3	7.5	7.1	7.7	9.1	—
S %	1.07	1.17	1.27	1.41	0.54	0.85	0.11	0.63	1.01	0.50	1.62	0.16	0.63	0.08
Hard Asphalt %	nil	0.26	0.47	1.03	nil	nil	ni¹	0.10	0.09	trace	0.11	0.06	2.82	nil
Soft Asphalt %	nil	0.80	1.60	3.50	nil	nil	nil	nil	0.43	nil	nil	nil	0.02	nil
Carbon Residue %	0.06	0.81	1.65	3.73	0.01	0.01	0.02	0.17	1.09	0.13	0.17	0.50	2.02	nil
S.I. Temp. °C	262	262	262	265	268	263	261	262	279	272	268	273	520	259
I.B.P. °C	256	219	213	208	205	205	214	226	207	236	209	194	127	162
Vols. to 275°C	10.5	15.0	17.0	19.0	53.0	61.0	44.0	48.5	72.5	51.0	10.5	32.5	78.0	96.0
Residue %	11	21	28	58	3.5	3.5	7	8.5	10.5	5	45	27.5	3 5	1
Origin of fuels	Dist. from mixed crude mainly par.	Blend of dist. and residue mainly par.	Blend of dist. and residue mainly par.	Residue from mixed crude mainly par.	Gas Oil from Scotch shale (paraffins)	Dist. from mixed crude mainly par.	Dist. from naphthenic crude	Dist from naphthenic crude	Blend of dist. and resid. from napht.-arom. crude mainly napht.	Dist. from napht.-arom. crude mainly napht.	Blend of dist. and resid. from arom. crude	Residue from napht. crude	Creosote from low temperature carbonization of coal	Kerosene from same crude as No. 1

Table III

Correlation Coefficients for Properties of 14 Diesel Fuels

	Specific Gravity	Flash Point	Kinematic Viscosity	S.I.T.	Volatility to 527° F.	C/H Ratio
Specific Gravity		.85	.28	.75	—.07	.91
Flash Point	.85		.04	—.46	—.33	—.57
Kinematic Viscosity	.28	.04		—.35	—.52	—.08
S.I.T.	.75	—.46	—.35		.16	.88
Volatility to 527° F.	—.07	—.33	—.52	.16		.46
C/H Ratio	.91	—.57	—.08	.88	.46	

crease knocking in gasoline engines, and with very few exceptions, what is anti-knock in a carburetor engine is pro-knock in a Diesel, and vice versa.

By far the most important factor with regard to knock is the fuel, and investigations are in progress both here and abroad to determine which characteristics make a fuel well adapted to use in Diesel engines and how such characteristics may be obtained. A research along this line was initiated by the A.S.M.E. in 1928, and at present the S.A.E. and the A.S.T.M. are cooperating in the work with the first mentioned organization. Enough evidence has accumulated already to show that the anti-knock quality of a Diesel fuel is determined by its ignition characteristics. Fuels which are easier to ignite burn more smoothly, and, fortunately, these same fuels are best for easy starting and smooth idling.

The foregoing facts were forcefully brought out by an investigation conducted by Le Mesurier and Stansfield on behalf of the Anglo-Persion Oil Co. They investigated fourteen fuels with regard to their physical and chemical properties and with respect to their behavior in Diesel engines. The data thus obtained were analyzed by Dr. Schweitzer by a method much used in statistical work. By this method, for two groups of figures representing factors that are believed to be related to each other, the Pearsonian correlation coefficient is determined. If the relation is a direct proportion, the correlation coefficient is 1. If the relation is a close one (as, for instance, the height and weight of men), the correlation coefficient is high, for instance, 0.9 or 0.8. On the other hand, if there is no relation between the two groups of figures (as between the heights of men and their checking accounts), the correlation coefficient is close to zero.

In Table II the properties of the fourteen fuels are listed, and the interdependence between these properties is brought out by the correlation coefficients given in Table III. From this latter table it may be seen that the specific gravity has a high correlation with the flash point, the self-ignition temperature and the C/H ratio; that viscosity has no high correlation with any other property; that the self-ignition temperature has a high correlation with the specific gravity and the C/H ratio; that the volatility has no great correlation with any other fuel property, and that the C/H ratio has a rather high correlation with specific gravity. The C/H ratio is the weight proportion of carbon to hydrogen in the fuel.

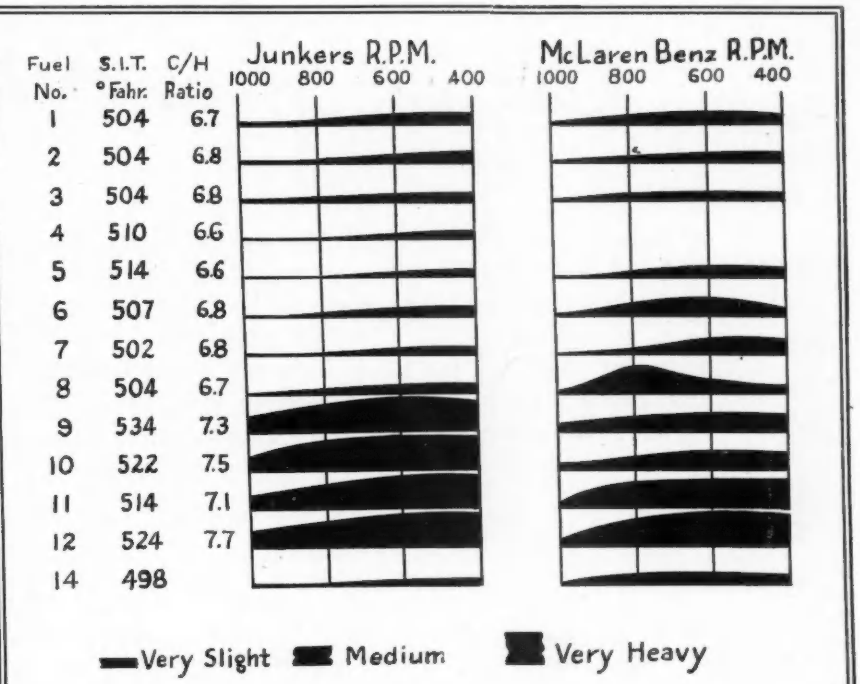
Le Mesurier and Stansfield also tested all of the fourteen fuels in several high- and low-speed Diesel engines and determined the "shock audibility," which was estimated by the ear and rated by a number. They also took indicator diagrams with a Farnboro indicator, from which they determined the delay angle and the maximum rate of pressure rise. The results confirmed the observation that the knock in Diesel engines is dependent on the rate of pressure rise. In the case of a Junkers engine in which different fuels were used, the correlation coefficient between shock audibility and maximum rate of pressure rise was 0.95, while in the case of a Robey engine it was 0.85. The maximum rate of pressure rise was found to be closely correlated to the delay angle, the correlation factor for these items in the case of a Junkers engine, tested with five different fuels, being 0.98. The direct correlation between shock audibility and delay angle was 0.92 in the Junkers engine and nearly equally high in the other engines.

In searching for smooth Diesel fuels we must therefore look for those which possess characteristics that favor fast ignition. There is comparatively little correlation between the speed of ignition and the flash point, the kinematic viscosity, and the volatility; but the self-ignition temperature has a correlation coefficient of 0.80 with the delay angle in the Robey engine, and of 0.75 in the Junkers engine. The C/H ratio has a correlation coefficient of 0.95 with the delay angle in the Junkers engine running at 500 r.p.m., and of 0.60 at 1000 r.p.m., while in the Robey this factor is 0.92. The inference is that a low C/H ratio makes a smoother fuel. In view of the close relation between the C/H ratio and the specific gravity, the much decried practice of judging fuels by their gravity is not so foolish after all. Of course, even with the same specific gravity, the composition of the fuel may vary widely. Fuels of high octane number usually have a higher C/H ratio than those with low octane number, and the constituents most undesirable in gasolines are probably the most desirable in Diesel fuels.

Table IV

Correlation Coefficients for 12-13 Fuels in Junkers Engine

	Shock Audibility	Delay Angle	S.I.T.	C/H Ratio
Shock Audibility		0.92	0.64	0.86
Delay Angle	0.92		0.75	0.95
S. I. T.	0.64	0.75		0.88
C/H Ratio	0.86	0.95	0.88	



Knock intensity with different fuels as affected by engine speed

From Table IV it is apparent, however, that neither the self-ignition temperature nor the C/H ratio alone determines the knock behavior of a Diesel fuel. Fig. 2, which is reproduced from Le Mesurier and Stansfield's paper, also shows that same fuels behave differently in different types of engines, and that the roughness depends a great deal on the engine speed. It also shows that the fuels do not rank with respect to smoothness of operation in the same order as with respect to their self-ignition temperatures or their C/H ratios. The McLaren-Benz engine, for instance, ran more smoothly with the No. 10 than with the No. 11 fuel at all speeds, although the former had both a higher self-ignition temperature and a higher C/H ratio.

Although fuel is the most important factor in connection with Diesel knock, engine-design factors also enter into the problem, which consists essentially in transferring heat from the compressed air to the fuel particles in the shortest possible time. The time required to heat the fuel particles up to the ignition temperature increases with a decrease in the temperature of compression, with a decrease in the relative velocity between the hot air and the fuel globules, and with increase in the size of the fuel globules. In a non-turbulent engine the "warming-up" period may be decreased by so directing the spray that the smallest fuel particles quickly reach the hottest part of the combustion chamber. In a high-turbulence type of engine the spray should first meet a part of the air stream which has not been "chilled" appreciably by flowing over a comparatively cool surface. A high inlet-air temperature, a high cylinder-head temperature and an extra-high compression ratio all have a beneficial effect on the ignition lag, though they may be objectionable for other reasons.

Cutting the ignition lag is one way to reduce the knock; another is to reduce the amount of fuel introduced into the cylinder during the ignition-lag period. If the rate of fuel delivery were small at the beginning of injection, and increased gradually, the total amount of fuel injected during the delay period would be less, but, unfortunately, injection usually starts with a spurt and decreases toward the end of the period. One possible reason for this is the arrival of a pressure wave at the nozzle valve at the moment the latter opens, and another that the moment the injector valve leaves its seat the pressure gets behind it and exerts an additional lifting action. It is desirable to have the injection begin very gradually.

Oberhaensli Diesel Powers Conventional Truck in Test

THROUGH the courtesy of Julius Kuttner, we observed the performance of a heavy-duty truck of well-known make powered by a Diesel engine and carrying a useful load of seven tons. The engine was a four-cylinder Oberhaensli Diesel, 5 x 7 in., operating at a governed speed of 1800 r.p.m.

General performance characteristics, such as acceleration, top speed and tractive ability were about the same as would be expected of a gasoline-engine truck of this type, but the truck started from a dead stop in second gear each time. It started easily from cold when cranked by a 24-volt starting motor. The exhaust was clear under all conditions, despite recent reports that this is practically impossible with a Diesel engine.

The engine ran on ordinary furnace oil and is said to show a fuel economy of 10 miles to the gallon.

It is astonishing to find how little radiator capacity this job required. The truck was run a number of city blocks with the radiator shutters closed to warm up the engine. This reflects the high thermal efficiency of the Diesel cycle, since more of the heat of combustion is converted into useful work and less is dissipated as waste heat.

One of the most important features of the engine is the governor control, recently designed by Mr. Kuttner. It governs both the top speed and the idling speed. Starting requires injection advance, which is achieved by cutting out the governor by a dash control, which simultaneously alters the point of injection. When starting cold, the engine knocks noticeably. This persists until the engine is warm and disappears when switched to governor control.

The Oberhaensli Co. does not plan to sell engines in the U. S. but to issue licenses to gasoline engine builders for the use of the patented divided combustion chamber and governor control. Stock gasoline engines of sufficiently heavy design can be readily altered so they can be converted to Diesels merely by applying the interchangeable attachments.—*J. Geschelin.*

Calculation of Weight Transfer on

A knowledge of the weight transferred from rear to front wheels when the brakes are applied is important; it puts extra stresses on the front springs, axle, wheels and tires. In this article Mr. Heldt develops formulas for loads incurred when brakes are applied to two or four wheels of a tractor vehicle. A subsequent article will discuss the effects of six-wheel braking on a tractor-trailer combination

by P. M. Heldt

ALL engineers are familiar with the fact that when the brakes of an automobile are applied, some of the weight normally on the rear wheels is transferred to the front wheels, so that the front wheels press harder against the pavement than when the car is stationary. This transfer of weight from the rear to the front wheels occurs whether brakes are applied to the rear wheels or the front wheels, and is greatest, of course, when they are applied to all four wheels, since it depends upon the total retardation produced by brake action.

The effect of weight transfer as a result of brake action can be plainly seen when watching a car from the curb as it is being brought to a stop at a crossing. When the brakes are first applied there is a noticeable deflection of the front springs, indicating that these springs are being loaded more heavily; and as the car comes to a stop and retardation due to the brakes ceases, the front springs rebound noticeably to their normal position under static load.

The proportion of the total weight of a vehicle which is transferred from the rear to the front wheels depends not alone upon the rate of retardation but also upon the ratio of the height of the center of gravity of the vehicle to the wheelbase. For this reason the effect is particularly pronounced in certain trucks and trailers which are loaded to great heights. A knowledge of the amount of weight thus transferred is important not only because it affects the power of the front-wheel as compared with the rear-wheel brakes, but also because it puts important extra stresses upon the front springs, axle, wheels and tires. In this article it is proposed to develop formulae for the calculation of the amount of weight on all three pairs of wheels of a tractor and semi-trailer combination when the rear wheels and all four wheels of the tractor, respectively, are locked by the brakes. The problem of the distribution of weight when brakes are applied to all six wheels will be discussed in a subsequent article.

It is true that brakes are rarely, if ever, applied so hard that all four wheels of the tractor slip on the pavement, and the case considered is the limiting one which, while practically never reached, is at least closely approached when the brakes are applied for an emergency stop.

The following notations will be used in the work:

r_1, r_2 and r_4, static loads on tractor front and rear and trailer wheels.

R_1, R_2 and R_4, loads on tractor front and rear and trailer wheels when brakes are applied to tractor rear wheels.

RR_1, RR_2 and RR_4, loads on tractor front and rear and trailer wheels when brakes are applied to all four tractor wheels.

B and B_1, retarding forces on tractor and trailer respectively when brakes are applied.

$RR_{12} = RR_1 + RR_2$, load on all four tractor wheels when all four are locked by the brakes.

W, total weight of tractor.

W_1, total weight of trailer with load.

H, height of center of gravity of tractor.

H_1, height of center of gravity of trailer.

h, height of center of trailer coupling.

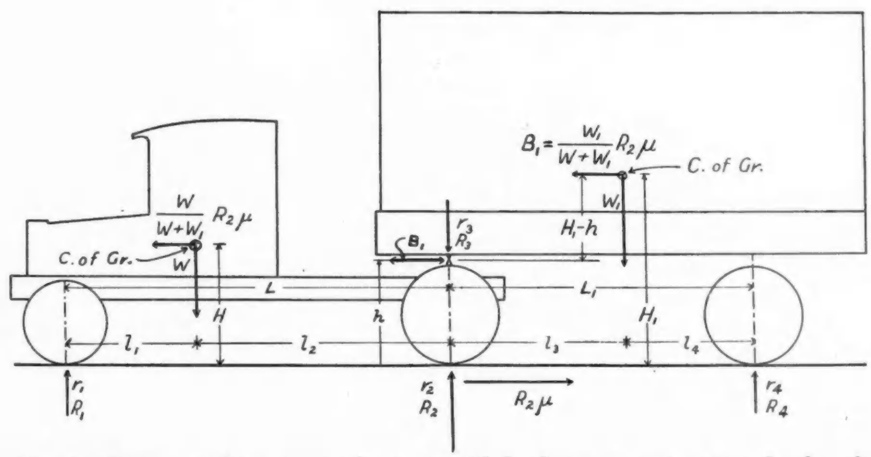


Fig. 1—Diagram of tractor trailer train with brakes on rear tractor wheels only

Tractor-Trailer Trains

L, wheelbase of tractor.
L_1, wheelbase of trailer.
l_1, horizontal distance from front axle to center of gravity of tractor.
l_2, horizontal distance from rear axle to center of gravity of tractor.
l_3, horizontal distance from center of trailer coupling to center of gravity of trailer with load.
l_4, horizontal distance from trailer axle to center of gravity of trailer with load.
μ, coefficient of friction between tires and ground.

Brakes on Tractor Rear Wheels Only

With the tractor rear wheels locked the reaction of the ground on these wheels is R_2 and the resulting retarding action is $R_2\mu$. Since both tractor and trailer are being retarded at the same rate, this retarding force is divided between them in the proportion of their weights. The retarding force on the tractor therefore is

$$B = \frac{W}{W + W_1} R_2 \mu,$$

and that on the trailer,

$$B_1 = \frac{W_1}{W + W_1} R_2 \mu$$

The latter expression represents the reaction between the tractor and trailer at the coupling, and there is an equal forwardly-directed force acting at the center of gravity of the trailer with load. Referring to Fig. 1, we can now take moments around the points of ground contact of the trailer wheels and get

$$R_3 L_1 + \frac{W}{W + W_1} R_2 \mu\ h = W_1 l_4 + \frac{W_1}{W + W_1} R_2\ \mu H_1$$

from which it follows that

$$R_3 = W_1 \frac{l_4}{L_1} + \frac{W_1}{W + W_1} R_2 \mu \frac{H_1 - h}{L_1}$$

The first term of the right-hand side of the above equation represents the weight on the bolster when the train is at rest, and the second term therefore represents the weight transfer.

The static load on the trailer wheels is $W_1\ (l_3/L_1)$, and the load on the trailer wheels when brakes are applied to the tractor rear wheels therefore is

$$R_4 = W_1 \frac{l_3}{L_1} - \frac{W_1}{W + W_1} R_2 \mu \frac{H_1 - h}{L_1}$$

In the case of the tractor we have the following forces acting when the rear wheels are locked by the brakes:

A force $W/(W + W_1)\ R_2\ \mu$ in a forward direction at the center of gravity.

A force $W_1/(W + W_1)\ R_2\ \mu$ in a forward direction at the coupling.

A reaction R_1 upward at the points of ground contact of the forward wheels.

A downward force W at the center of gravity.

A rearwardly directed force $R_2\ \mu$ at the points of ground contact of the rear wheels. Now, taking moments about the line of ground contact of the rear wheels we get:

$$R_1 L = W l_2 + \frac{W}{W + W_1} R_2 \mu H + \frac{W_1}{W + W_1} R_2 \mu\ h$$

And

$$R_1 = W \frac{l_2}{L} + \frac{W}{W + W_1} R_2 \mu \frac{H}{L} + \frac{W_1}{W + W_1} R_2 \mu \frac{h}{L}$$

$$= W \frac{l_2}{L} + \frac{W H + W_1 h}{L(W + W_1)} R_2\ \mu$$

The first term of this expression represents the static load on the front wheels and the second the amount of weight transferred to them by the application of the brakes on the rear wheels to the locking point.

Now, the reaction on all three pairs of wheels combined naturally must be equal to the combined weights of the truck and trailer; hence:

$$R_1 + R_2 + R_4 = W + W_1$$

Substituting the values found for R_1 and R_4 we get

$$W \frac{l_2}{L} + \frac{W H + W_1 h}{L(W + W_1)} R_2 \mu + R_2 + W_1 \frac{l_3}{L_1} - \frac{W_1}{W + W_1} R_2 \mu \frac{H_1 - h}{L_1} = W + W_1$$

But

$$W - W \frac{l_2}{L} = W \frac{l_1}{L} \text{ and } W_1 - W_1 \frac{l_3}{L_1} = W_1 \frac{l_4}{L_1}$$

and making these substitutions we get

$$W \frac{l_1}{L} + W_1 \frac{l_4}{L_1} = R_2 \left[1 + \frac{W H + W_1 h}{L\ (W + W_1)} \mu - \frac{W_1}{W + W_1} \mu \frac{H_1 - h}{L_1} \right]$$

so that

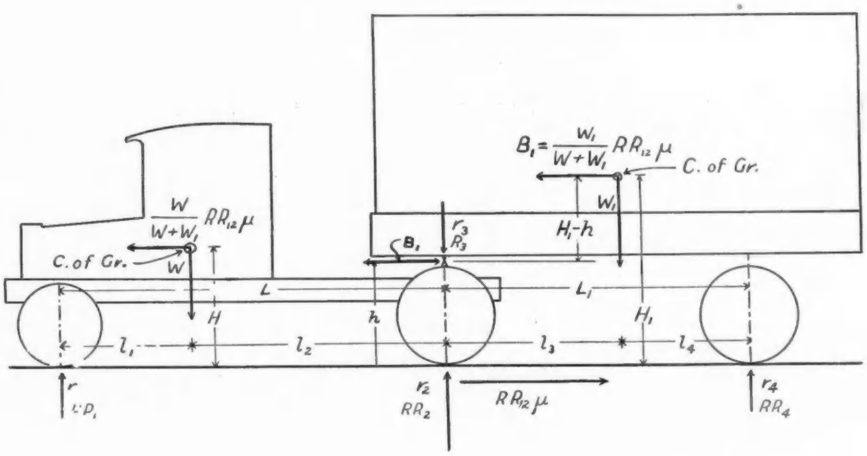
$$R_2 = \frac{W \dfrac{l_1}{L} + W_1 \dfrac{l_4}{L_1}}{1 + \dfrac{W H + W_1 h}{L(W + W_1)} \mu - \dfrac{W_1}{W + W_1} \mu \dfrac{H_1 - h}{L_1}}$$

It is interesting to note that in the foregoing expression the numerator represents the static load on the tractor rear wheels and the denominator is a ratio which is usually somewhat greater than 1 and which represents the change in load on the rear wheels of the tractor due to the application of brakes to them.

The value of R_2 thus found might be substituted in the equations for R_1 and R_4, but the expressions thus obtained would be rather complicated, and it is preferable to first calculate the value of R_2 and substitute it

Brakes on all four tractor wheels

Fig. 2—Diagram of tractor-trailer train with brakes applied to all four tractor wheels



in the equations for the loads on the tractor front wheels and the trailer wheels.

Brakes on all Four Tractor Wheels

The total load on the four tractor wheels under brake action on all of them being designated by RR_{12}, the retarding force is $RR_{12}\,\mu$. Of this retarding force the portion on the trailer will be $W_1/(W + W_1)\,RR_{12}\,\mu$, and that acting on the tractor, $W/(W + W_1)\,RR_{12}\,\mu$. The former expression again represents the force with which the trailer pushes forward on the tractor when the brakes are applied to the wheels of the latter, and there is an equal inertia force acting at the center of gravity of the trailer with load.

We now take moments around the coupling axis and get (Fig. 2):

$$RR_4\,L_1 + \frac{W_1}{W + W_1} RR_{12}\,\mu\,(H_1 - h) = W_1\,l_3$$

so that

$$RR_4 = W_1 \frac{l_3}{L_1} - \frac{W_1}{W + W_1} RR_{12}\,\mu \frac{(H_1 - h)}{L_1}$$

Now,

$$RR_4 + RR_{12} = W + W_1,$$

hence,

$$RR_{12} + W_1 \frac{l_3}{L_1} - \frac{W_1}{W + W_1} RR_{12}\,\mu \frac{(H_1 - h)}{L_1} = W + W_1$$

$$RR_{12}\left[1 - \frac{W_1}{W + W_1}\,\mu\,\frac{(H_1 - h)}{L_1}\right] =$$

$$W + W_1 - W_1 \frac{l_3}{L_1} = W + W_1 \frac{l_4}{L_1}$$

$$RR_{12} = \frac{W + W_1 \dfrac{l_4}{L_1}}{1 - \dfrac{W_1}{W + W_1}\,\mu\,\dfrac{(H_1 - h)}{L_1}}$$

Next we consider the forces on the tractor. Here we have a load RR_1 on the front wheels, a load W acting downward at the center of gravity, an inertia force $W/(W + W_1)$ at the center of gravity, directed forward, and a force $W_1/(W + W_1)\,RR_{12}\,\mu$ pushing forward at the coupling. By now taking moments on the line through the centers of ground contact of the rear wheels we get

$$RR_1\,L = W\,l_2 + \frac{W}{W + W_1} RR_{12}\,\mu\,H + \frac{W_1}{W + W_1} RR_{12}\,\mu\,h$$

$$RR_1 = W \frac{l_2}{L} + \frac{W}{W + W_1} RR_{12}\,\mu \frac{H}{L} + \frac{W_1}{W + W_1} RR_{12}\,\mu \frac{h}{L}$$

In the right-hand member of the equation the first term represents the static load on the front wheels of the tractor; the second term represents weight transferred from the rear wheels to the front wheels of the tractor due to the inertia of the tractor mass, and the third term represents weight transferred to the tractor front wheels as a result of inertia of the mass of the trailer with load. The trailer naturally pushes against the coupling when the brakes are applied to the tractor wheels, and thereby adds to the weight on the tractor front wheels.

In applying the foregoing to an actual case, the total load on the tractor wheels under brake action, RR_{12}, is first found by means of the equation given for it. This value is then inserted in the equation for the load RR_1 on the front wheels of the tractor, and this equation is then solved. The load on the tractor rear wheels is value is then inserted in the equation for the load RR_1 and that on the trailer wheels by subtracting RR_{12} from the combined weight of the tractor and trailer (with load).

To give an idea of the amounts of weight transfer as a result of brake application the equations have been applied to the case corresponding to the following data:

W, 6000 lb.	L_1, 180 in.
W_1, 24,000 lb.	l_4, 80 in.
L, 140 in.	H_1, 65 in.
l_2, 75 in.	h, 35 in.
H, 28 in.	μ, 0.6

The results obtained are tabulated below.

Weight Distribution of Tractor-Semi-Trailer Train

	Static	Tractor Rear Brakes Applied	Tractor Four-Wheel Brakes Applied
Tractor front wheels	3,210	5,025	5,815
Tractor rear wheels	13,440	12,620	12,285
Trailer wheels	13,350	12,355	11,900
Total	30,000	30,000	30,000

S. A. E. Truck Rating Solution is Due

Committee is Expected to Agree on Performance Factor at Summer Meeting

by James W. Cottrell

TUESDAY, June 14, 1932, may perhaps become a red-letter day in truck history. The S.A.E. is expected to evolve a truck rating to replace the former manufacturer's payload tonnage system. In any case it will be eventful because L. R. Buckendale, chairman of the Motor Truck Rating Committee, has summoned his associates to dine, to propose, to discuss and to decide during the evening of the second day of the sessions of the annual summer meeting of the S.A.E. at White Sulphur Springs, W. Va. Neither the chairman nor any other person doubts the fulfillment of the first three requests; interest hinges upon the committee's vote.

Many signs point to adoption of some rating plan during the meeting. Discussions during meetings in Atlantic City, Washington and Detroit have cleared up a lot of difficulties and crystallized opinion in favor of a rating formula program.

That the rating, when, as and if adopted, shall contain a performance factor is now generally agreed. The Buckendale formula calculated vehicle gross weight from known and assumed facts. It said nothing at all about speed and assumed a given grade as a part of the calculation of gross weight. Performance was actually in the formula but not in the answer.

The proposed rating method which will come before the committee includes three factors: weight, grade ability and speed. They are defined briefly as follows:

1. Gross Vehicle Weight is set by the manufacturer and must not exceed the capacity of the tires on the vehicle.

2. Grade Ability factor is the maximum grade expressed in per cent which the vehicle can climb in direct gear. It is expressed by formula:

$$\textit{Per cent grade} = 100\left(\frac{T \times 12 \times e \times R}{r \times GVW}\right) - RF$$

Torque, expressed as *T*, equals piston displacement in inches multiplied by .625. Rolling radius of tires loaded to capacity is expressed as *r*. Road rolling resistance, *RF*, is established for purposes of calculation as 1.5 lb. per 100 lb. gross weight. Efficiency from engine to tires has been assumed at 90 per cent.

3. Maximum top speed, expressed in miles per hour as guaranteed by the manufacturer or fixed by governor setting.

Although the grade ability and the Buckendale formulas are similar mathematically, they denote a different approach to the problem. The grade formula uses a predetermined vehicle gross weight to determine ability; the Buckendale formula sought to determine the gross weight rating from given facts.

Members of the committee have been asked to submit their ideas to the White Sulphur Springs session, and it is expected that they will include various alterations in the factors of the formula or substitutions of other factors.

M. C. Horine, Mack, suggested an entirely different way of expressing performance ability during the Detroit meeting. He proposes a factor denoting "horsepower per pound of gross vehicle weight multiplied by a constant." The factor is expressed as

$$PF = \frac{33{,}750 \times \textit{brake hp.}}{\textit{gross vehicle weight}}$$

or $PF = \textit{Speed in m.p.h.}$ (*Per Cent grade* + *100* × *Road Factor*)

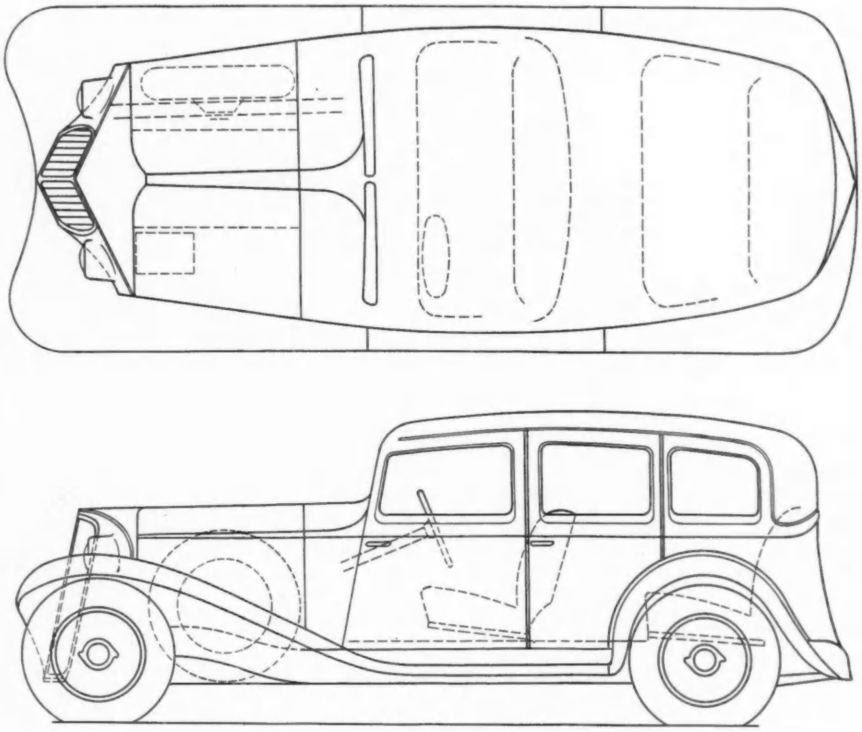
For a vehicle with 20,000 lb. gross weight, 104 hp. at 2500 r.p.m. rear axle ratio 8.00 and 9.75/20 tires, the performance factor is the simple figure 175. More figuring with the formula shows that the vehicle can climb a 4 per cent grade at 35 m.p.h.

Mathematicians enjoy working out variations of

(*Turn to page 863, please*)

Streamline Design Adaptable To Conventional Car Chassis

by
E. S.
Sutton



Streamlined body proposed by Mr. Sutton, in plan and side elevation

THE aerodynamically streamlined car is coming. No doubt about that. Not necessarily a rear-engined, tear-drop design as advocated by some engineers—the American public is not likely to accept such a radical creation for some time to come—but a gradual change of the present day automobile into a more scientifically shaped vehicle, better suited to modern high-speed travel, seems inevitable.

The first move in this process of evolution has already been made. It consisted of the slanting of the radiator and windshield, the omission of the air-catching visor, and the rounding of the roof and side posts in front. The next changes will be a further smoothing out of the front end and a removal of the many exposed and eddy-forming accessories like head lamps, horns, license-plate holders, fender braces, spare wheels, luggage trunks, etc.; also a gradual widening of the front part of the car and a narrowing down of the rear.

That a fairly close approximation to this shape of minimum wind resistance can be attained on the conventional chassis merely by the various changes just outlined is indicated by Fig 1. It shows a car with a broad radiator shell having built-in head lamps and extending from fender skirt to fender skirt, a wider hood, a front seat accommodating three passengers and a narrower rear seat for two only.

This novel seating arrangement is the characteristic feature of the design. It not only permits of a car exterior having less wind resistance, but is undoubtedly the more sociable arrangement of the seats. Even today, when only three people ride in a five-passenger car, they will generally crowd into the front seat, the odd passenger disliking to ride by himself in the rear. Further advantages of this seating arrangement are that the majority of the passengers are located at the point of greatest riding comfort, and that the broadening of the hood makes it possible to arrange spacious storage compartments under same alongside the powerplant. The customary square luggage trunk at the rear of the car is of course out of place on a streamline design, and these hood compartments serve as a good substitute.

A very much better streamlined car can therefore be made on the conventional chassis by comparatively minor changes in the superstructure.

TESTS with ethylized gasoline in tractor engines with increased compression ratio, made in the Detroit laboratory of the Ethyl Gasoline Corp., indicate that anti-knock gasolines can now be used more economically than kerosene in farm tractors. The tests are said to have shown that a tractor which will pull two 16-in. plows in ground-breaking operations on kerosene, after alterations and when using anti-knock fuel, will pull three 16-in. plows at a speed 7 per cent higher. Another thing tending to favor the use of anti-knock fuels in tractor engines is that the price of kerosene is rising, due to the shrinking demand and consequent increase in cost of distribution. Moreover, 26 of the 38 states which levy a tax on gasoline, refund it if the fuel is used for agricultural purposes. According to a survey made by engineers of the Ethyl corporation, gasoline is being used at present in 82 per cent of the tractors which were designed to operate on kerosene.

Industry to Pay One-Fourth Of Total Federal Tax Levies

by L. W. Moffett

Revenue Act, Approved by President, Effective June 21 to July 1, 1934, Costing the Motorist $275,000,000

WASHINGTON, June 9—The hodgepodge known as the revenue act of 1932 was signed by President Hoover June 6, and it becomes a law 15 days later, June 21.

The motorist and truck owner will be soaked to the tune of $275,000,000, or one-fourth of the estimated revenue from the entire act, though it is actually believed the law will fall considerably short of raising the $1,115,000,000 as predicted by easy optimists, "balance the budget" sloganeers and mere politicians.

Meanwhile salesmen will do well to get busy. The tax man is on the trail of the motorist and trucker and everything they use.

All of the trimmings are included. Passenger cars, trucks, accessories, lubricating oil, tires and inner tubes and gasoline are gathered in the grasp of the revenue man.

While the House had spared some of these levies, the Senate was less generous and slapped all of them back on again. And they went into the bill as finally signed by the President, as had been expected.

The Senate, with vigorous encouragement — if not demand — by the Treasury Department, insisted on its pound of flesh. Until July 1, 1934, the Internal Revenue collectors will be forced into the role of Shylocks garnering all of these taxes, except in the case of the domestic tax on gasoline. This levy is to expire in one year.

This heavy assessment on the automotive and related industries—or their users—comes from the following taxes that have been adopted:

Passenger cars, 3 per cent of the wholesale (manufacturer's) price.

Trucks, 2 per cent of the wholesale price.

Parts and accessories, 2 per cent of the wholesale price.

Domestic lubricating oil, 4c per gal.
Imported lubricating oil, 4c per gal.
Tires, 2¼c per lb.
Inner tubes, 4c per lb.
Domestic gasoline, 1c per gal.
Imported gasoline, 2½c per gal.

It will be seen that the tax on passenger cars, trucks and parts and accessories will be levied on the price at which the manufacturer sells to the dealer or distributor. To illustrate, if the price made on a passenger car to a dealer by the manufacturer is $700, f.o.b. Detroit, the tax would be $21. Assuming the same price made on a truck to the dealer, the tax would be $14.

With parts and accessories, the operation of the tax may be different, though the principle is identical. Because these supplies often cost so little, it may often be difficult for the dealer to pass the taxes on to the ultimate consumer. Placing a tax of 1c on a spark plug costing the dealer 50c, for example, might not be practicable in these days of keen competition.

The 4c per gallon on domestic lubricating oil rests at the place of production as does the 1c a gal. on gasoline rest at the refinery, while the import taxes rest on the importer. But they assuredly will be passed on in part or altogether to the consumer.

The taxes on tires and inner tubes are something new in legislative philosophy, if any, and their operation is going to call for regulations. These will be worked out between the Bureau of Internal Revenue and the rubber industry. Since the taxes are to be levied on a weight basis it is altogether probable that during their application the motorist will see himself buying tires and inner tubes that are labeled with their weight. These weights, even on given sizes of tires and tubes, likely will vary somewhat, since there is a difference in weights between different producers. The tax on casings excludes the metal rim or base.

The taxes on tires and tubes will be paid by the automobile or truck manufacturer when buying them for equipping their cars and trucks. He will be given credit for the tire and tube taxes to the amount of the difference between such taxes and the taxes of 3 and 2 per cent respectively on passenger cars and trucks.

When tires and tubes are bought by the ultimate consumer for placing on his car or truck, the tax will be in his costs, assuming it is not absorbed either in part or wholly between the plant of production and source of consumption.

The manufacturer of tires and tubes of course also would be required to pay the tax when selling to distributors, and, it is to be assumed, pass it on to the distributor, who in turn would pass it on to the consumer, competitive or other conditions making that possible, as it apparently will be. Otherwise the narrow margins now prevailing, if present at all, for producers and dealers would disappear.

(Turn to page 865, please)

Statement showing effect on dealers' business of proposed tax of 2¼ cents per pound on tires

	Weight of Tire and Flap	Dealer's Net Purchase Price	Tax at 2¼ cents per Pound	Ratio of Tax to Purchase Price
First-line tires:	Pounds			Per cent
4.50-21, 4-ply..	15.28	$4.82	$0.34	7.13
4.75-19, 4-ply..	16.70	5.26	.38	7.13
5.25-18, 4-ply..	18.37	6.36	.41	6.45
5.50-18, 4-ply..	21.18	7.07	.48	6.83
6.00-18, 4-ply..	23.39	7.86	.53	6.68
7.00-18, 6-ply..	37.45	12.45	.84	6.75
30 by 5, 6-ply.	34.20	11.39	.77	6.75
32 by 6, 8-ply.	47.98	18.41	1.08	5.85
34 by 7, 10 ply	86.75	31.99	1.95	6.08
6.00-20, 6-ply, bus	34.84	11.85	.78	6.60
Second-line tires:				
4.50-21, 4-ply..	14.93	4.06	.34	8.33
4.75-19, 4-ply..	15.61	4.73	.35	7.48
5.25-18, 4-ply..	18.07	5.61	.41	7.20
5.50-18, 4-ply..	20.46	6.25	.46	7.35
6.00-18, 4-ply..	None	....	....	....
7.00-18, 6-ply..	None	....	....	....
30 by 5, 8-ply..	40.07	10.81	.90	8.33
32 by 6, 8-ply..	None	....	....	....
34 by 7, 10-ply.	81.52	25.41	1.64	7.20
6.00-20, 6-ply, bus	33.52	10.14	.76	7.50

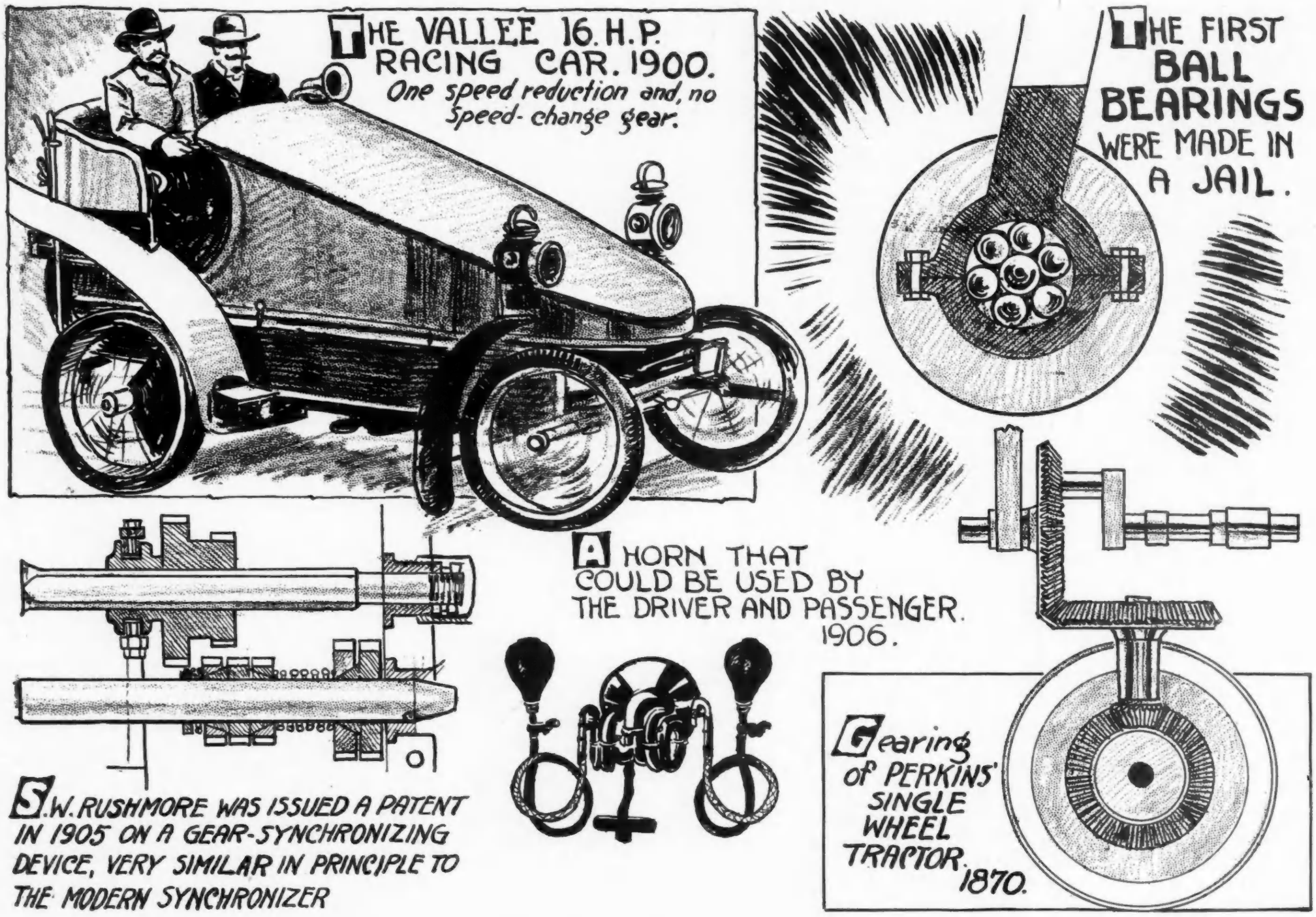
Statement showing effect on dealers' business of proposed tax of 4 cents per pound on tubes

	Weight of Tube	Dealer's Net Purchase Price	Tax at 4 cents per Pound	Ratio of Tax to Purchase Price
First-line tubes:	Pounds			Per cent
4.50-21, Group B	2.00	$0.83	$0.08	9.60
4.75-19, Group B	2.31	.83	.09	11.52
5.25-18, Group C	2.40	.95	.09	10.08
5.50-18, Group F	2.98	1.17	.12	10.24
6.00-18, Group F	2.98	1.17	.12	10.24
7.00-18	3.92	1.48	.16	10.80
30 by 5	3.59	....	.14	....
32 by 6	7.70	2.39	.31	13.04
34 by 7	11.76	3.48	.47	13.60
6.00-20	3.97	1.57	.16	9.36
Second-line tubes:				
4.50-21, Group B	1.82	.58	.07	12.40
4.75-19, Group B	1.92	.66	.08	11.90
5.25-18, Group C	2.13	.75	.09	11.76
5.50-18, Group F	2.68	.90	.10	11.52
6.00-18, Group F	2.68	.90	.10	11.52
30 by 5	3.15	1.17	.12	10.24
32 by 6	5.05	1.78	.20	11.20
34 by 7	9.20	2.53	.37	14.56
6.00-20	2.97	1.06	.12	11.36

Statement showing effect on dealers' business of proposed tax of 2¼ cents per pound on solid truck tires

Size	Weight of Solid Tire, Excluding metal base	Net Dealers' Billing Price	Tax at 2¼ cents per Pound	Ratio of Tax to Billing Price
	Pounds			Per cent
36 by 5 heavy duty cushion	80.9	$27.02	$1.82	6.73
36 by 6	102.9	34.49	2.31	6.07
36 by 8	139.1	49.88	3.12	6.25
36 by 10	193.7	63.25	4.36	6.89
40 by 14	301.9	97.61	6.79	6.95

Automotive Oddities—By Pete Keenan



Write us if you know an oddity

The NEWS TRAILER

The thrift-model urge has apparently struck the motorcycle industry. Indian Motocycle is coming out with a lightweight which will sell for $225. Although popular in Europe, lightweights are not so well known in this country. One of the interesting things about them is the use of a "steering damper" to compensate for lack of weight in resisting road shocks.

Ford Motor of England has inaugurated a touring-hire service which includes delivery of a Ford car, with or without chauffeur, to any quay where trans-oceanic steamships arrive. Tourists may hire the car for any period from a weekend to six months long. Other British automobile manufacturers seem to be taking an interest in the same sort of venture, which was pioneered in Europe, we believe, by Daimler.

The Atlantic City Speedway, which aroused quite some bubbles in racing circles during 1926 and 1927, was scheduled to be sold by the sheriff on June 3. Now, it appears, the sale has been postponed until June 17, at which time it will positively be sold to the highest legitimate bidder, etc., etc. Racing fans will shed a tear or two at the news, particularly as there seems no hope that the Speedway will ever function *qua* Speedway again. Formed by a syndicate in which Charles M. Schwab had an active and monetary interest, the Speedway corporation set up one of the most ambitious automobile racing programs ever attempted.

The track was constructed along the arterial road between Philadelphia and Atlantic City, N. J., partly on the site of Amatol, the town which during the War housed the largest shell-loading depot in the world. At the opening race seats were priced around $15, yet the crowd was immense. Paradoxically, the latter condition was one of the things which injured the prospects of the track. The crowd was so big that it took hours to get its personal automobiles untangled from parking spaces and out on the road again. A relief road was built later, but the damage had already been done in this connection.

After a meteoric career, during which it was rather definitely established as the fastest Speedway, the Amatol venture began to lose money too rapidly to suit the promoters. Before it was finally abandoned the Speedway had been the scene of some spectacular stock-car trials, including the Auburn 15,000-mile go and the Studebaker 30,000-mile run.

NEWS

Tax Effective On June 21

The Treasury Department has ruled that all tires, vehicles and accessories bought and delivered before midnight of June 20 will be tax free but that all goods bought or delivered after that time will pay the new excise tax, according to an announcement broadcast to its members by the National Automobile Chamber of Commerce.

A committee of the Chamber, of which L. A. Moehring (Chrysler) is chairman with H. W. Webster (General Motors) and John E. Walker (Nash, White, Mack), met with Treasury officials at Washington June 7 to obtain final regulations which will later be sent to all members of the Chamber.

Canada Clarifies Tariff Position

Rules on Determination of Percentage of Car Made in Dominion

TORONTO, June 6—With the Imperial Economic Conference only a few weeks away, the Canadian Government has made a significant announcement with regard to the Canadian content of automobiles built or assembled in the Dominion for excise purposes.

The Ministry of National Revenue has made a ruling to determine whether or not the required 50 per cent of a finished automobile has been produced in the Dominion.

The regulations laid down provide that the cost of producing an automobile, truck or chassis shall be held to include the total factory or works cost, comprising labor materials and factory overhead, and also that portion of the administrative expense that is directly applicable to the manufacture of the unit but not including sales and advertising expenses.

This ruling is of particular importance in the export of cars and trucks to other countries that have been built or assembled in Canada according to design or pattern originating in the United States. Some difficulty had been experienced in deciding when an automobile could be classed as Canadian-made. In this connection, the exclusion under the ruling of sales and advertising expenditures is an important new item.

There are many plants, all of which are located in Ontario, in which leading makes are built for both domestic and export trade, these including the General Motors group, the Chrysler group, Ford, Studebaker, Rockne, Pierce-Arrow, Graham, Hupmobile, Packard, Willys-Overland, Hudson, Essex, Reo and Durant.

New regulations affecting the manufacture and export of automotive vehicles within the British Empire may be generally adopted following decisions on the subject at the Empire Conference opening July 21 at Ottawa. Canadian automobile companies are preparing information on trade features for the consideration of delegates at this conference.

Tire Companies Speed Up; Anticipating Pre-Tax Business

AKRON, June 7—The smaller rubber companies of the Akron district are now operating at the peak of their capacities, a survey of the industry this week reveals.

The larger companies, including Goodyear, Goodrich, Firestone and General, also are increasing their production and shipments considerably this month, due in part, officials admit, to the fact dealers are loading up with tires in anticipation of an additional cost burden when the proposed Federal tax is saddled upon the manufacturers.

India Tire & Rubber Co., Mogadore, Akron suburb, one of the smaller companies dealing exclusively in the replacement business, is now operating four six-hour shifts a day seven days a week and is employing more men than at any time in the history of the company, President W. G. Klauss announced this week. The company made a 33 1/3 per cent addition to its working force by the four-shift-a-day plan, Klauss said.

The plan was first tried at India last summer to provide better conditions for the pit men and proved so satisfactory it was extended to the entire working force this summer.

The seven-day week came into being with the recent increase in production schedules.

"The six-hour shift plan brings better attendance, better workmanship and better health to the workers," Klauss said in advocating general adoption of the plan in the rubber industry.

The Falls Rubber Co. of Cuyahoga Falls is another of the smaller rubber companies of the district now working at capacity to keep up with orders. The plant is a subsidiary of the Master Tire and Rubber Corporation which operates other factories in Findlay.

Frank C. Millhoff, vice-president, announced his Falls plant shipped more casings and tubes in May than in any previous month of its history. June shipments are expected to set a new peak for the 23 years of the company's history, Millhoff said.

"We are deluged with orders here, and also at Findlay where the Cooper Corporation and the Giant Tire & Rubber Co. are located."

The hot weather seasonal impetus and the prospect of the Federal tax are responsible for some increase in orders, sales managers of all the companies say. "But viewed from any angle, the large increase in orders is encouraging," one manager said.

Budd Names Harder

The Edward G. Budd Mfg. Co. announces that D. S. Harder has been appointed works manager in charge of production of the Budd plants in Philadelphia and Detroit. Mr. Harder, formerly works manager of the Budd Detroit plant, has moved his headquarters to Philadelphia. LeRoy A. Coleman is production supervisor in the Detroit unit.

Auburn Declares

Auburn Automobile Company has announced declaration of its regular quarterly dividend of $1 a share cash and the usual additional dividend of two per cent payable in stock. The dividend voted is payable July 1, 1932, to stockholders of record at the close of business June 21, 1932.

Bob Carey Wins Detroit Race

Event is Stopped Before 100 Miles by Threat of Rain

DETROIT, June 6—Bob Carey, driving the Meyer special with which he placed fourth at Indianapolis, was awarded the 100-mile race here yesterday when the race was called on account of a rain which did not materialize. At the time Carey had completed 84 miles. Howdy Wilcox in a Lion Head special was in second place, and Fred Frame, Indianapolis winner, with a Duesenberg, third at the time the race was called.

Russell Snowberger with his converted Hupmobile placed sixth as he did at Indianapolis. Other stock cars failed to place. Average time for Carey's 84 miles was 71.57 miles per hour.

It was a disgruntled bunch of drivers generally following the race. While the blame for this can hardly be laid on the shoulders of W. D. Edenburn, steward and umpire, it did reflect on the management of the race generally. The day began with a half-hour delay of the race to permit Lou Schneider to qualify. His qualification, finally, forced another driver, Al Aspen, out of the race.

The race had barely proceeded one-quarter of its distance when drivers were given a caution signal to "hold their pace." Investigation disclosed that promoter Chester M. Howell had mistaken an argument in the crowd of spectators for a smash-up. Culminating the day, the race was called at 84 miles on account of a "rain" which had only threatened. Attendance was apparently considerably under last year.

Demand for Fuel Expected to Decline

During the last nine months of this year it is estimated that the total demand for motor fuel will drop 6.2 per cent, as compared with the last nine months of 1931. The estimate is contained in a report transmitted to the Federal Oil Conservation Board by its Volunteer Committee on Petroleum Economics. The report states, in part:

"It is estimated that the total demand for motor fuel will be 337,000,000 bbl., of which the domestic demand is estimated to be 307,500,000 bbl. and the export demand 29,500,000 bbl. The indicated decrease in domestic demand over the same period in the year 1931 is estimated to be 17,557,000 bbl., or 5.4 per cent, and the indicated decrease in export demand is estimated to be 4,832,000 bbl., or 14.1 per cent, resulting in an estimated decrease in total demand for motor fuel of 22,389,000 bbl., or 6.2 per cent. . . .

"The general historical trend of the domestic demand for motor fuel, with seasonal factors corrected, has been definitely downward for some time, this condition having been indicated even as early as the year 1929, when it became apparent that the rate of increase in domestic demand was decreasing.

"The committee has concluded that the principal factors causing the export demand for motor fuel to assume a pronounced downward trend will continue in effect during the period under consideration, but that the rate of decline in exports will be reduced due to the fact that the causative factors of decline have almost exerted their full effect. The decreased purchasing power of foreign consumers and the pressure of competition from foreign motor fuel producers, together with foreign agreements concerning the source of supply, will continue to be the major factors influencing a decline in export demand.

"It is estimated that the imports of motor fuel will total 8,700,000 bbl., a decline of 1,026,000 bbl., or 10.5 per cent below the same period in 1931. The unusually heavy imports in the first months of the year 1932, which is in effect a translation of stocks from other countries to this, appears to have been stimulated by the possibility of an excise tax on imports. It is not, however, anticipated that the same rate of importation will persist through the year, for if an excise tax is not imposed, imports should be reduced to compensate for the heavier imports in the early part of the year. If an excise tax, distinctly restraining, is imposed, imports will automatically decline to a low level or cease."

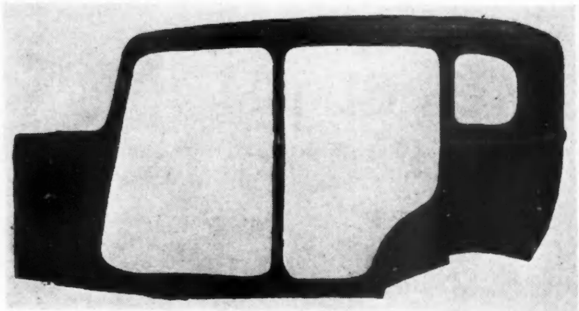
Budd Stamps Whole Rockne Side Panel From Single Sheet of Autobody Steel

This is the side panel of the Rockne of 1932. The E. G. Budd Mfg. Co. produces it. Here is perhaps the largest stamping produced in the automotive industry. The blank is 64 x 108 in.; the finished stamping encompassing the entire side from the back to the cowl is 101 x 51¼ in.; the sheet is 0.037 in. thick and of regular autobody stock.

In this design, the B & C post is a slender, symmetrical U-section only 1¼ in. wide with sides 2⅜ in. deep. Although the developed length of the section is almost 6 in., it fairs in beautifully at the door corners. The wheel house has a depth of 5⅝ in.

Here for the first time is a huge one-piece stamping complete in every detail and ready to assemble as it comes off the line from the final press operation.

The dimensions of the Rockne panel, as stamped by Budd, are as follows: Back to cowl and top to rail 101 in. by 51¼ in.

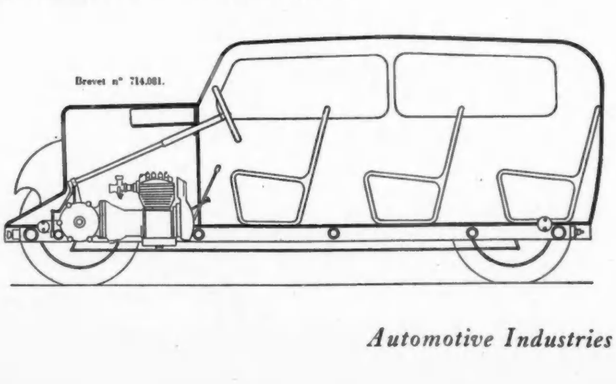


Leon Laisne Chassis

The Leon Laisne Co. of France, one of the pioneers of independent springing has patented (in France) the following type of vehicle intended to make cheap motoring possible. A very light frame of steel tubing, a metallic floor resting directly on the frame and united with it in any suitable manner; at the front and rear this floor is extended laterally to form the mudguards and in the middle to form the running board; a sort of housing (body) in one piece, with openings at the sides and at the rear. The seats are to be of the portable type.

Front-wheel drive is provided for and all wheels are independently sprung on cranked stub axles. The drawing reproduced herewith is from *L'Aluminium.*

The Leon Laisne economy chassis is shown in outline at the right



General Motor Sales in May With Figures for Comparison

Sales to Consumers in United States

	1932	1931	1930	1929
January	47,942	61,566	74,167	73,989
February	46,855	68,976	88,742	110,148
March	48,717	339,717	123,781	166,942
April	81,573	135,663	142,004	173,201
May	63,500	122,717	131,817	169,034
June		103,303	97,318	154,437

Sales to Dealers in United States

	1932	1931	1930	1929
January	65,382	76,681	94,458	95,441
February	52,539	80,373	110,904	141,222
March	48,383	98,943	118,081	176,510
April	69,029	132,629	132,365	176,634
May	60,270	136,778	136,169	175,873
June		100,270	87,595	163,704

Total Sales to Dealers in U. S. and Canada Plus Overseas Shipments

	1932	1931	1930	1929
January	74,710	89,349	106,509	127,580
February	62,850	96,003	126,196	175,148
March	59,696	119,195	135,930	220,391
April	78,359	154,252	150,661	227,718
May	66,739	153,730	147,483	220,277
June		111,668	97,440	200,754

Unit sales of Chevrolet, Pontiac, Oldsmobile, Buick, LaSalle and Cadillac passenger and commercial cars are included in the above figures.

Shows New Diesel

At the Spring Fair in Leipsic the German Works, a former munitions plant, now manufacturing railcars among other mechanical equipment, exhibited a Diesel engine specially designed for use in railcar service. According to a report in the ATZ, the six-cylinder engine has a bore of 225 mm. and a stroke of 300 mm. (8.86 by 11.81 in.) and develops 375 hp. at 900 r.p.m. The crankcase is cast of silumin, an aluminum alloy. Between the crankcase and the cylinder heads is placed a cast steel plate, and cylinder head, steel plate and crankshaft bearing caps are tied together by means of "through" bolts. Aluminum-alloy pistons are used, and are provided with Duplex rings. The piston pins are mounted in needle bearings. The specific output is 1 hp. per 17.6 lb. Experiments have been made with a supercharger.

Dodge Appoints

Dodge Bros. Corp. has announced the following appointments: R. C. Somerville, as sales representative, Peoria, Ill., zone. Mr. Somerville succeeds A. A. French. O. J. Loderick has been made sales representative in the Dallas zone, succeeding R. V. Allen. G. L. Mahon has been named truck representative in the Omaha and Des Moines zones of the Kansas City region.

Bearing Lubrication

A pamphlet on the subject, "Lubrication of New Departure Ball Bearings," has been published by the New Departure Manufacturing Co., Bristol, Conn. It is evidently the result of a thorough study of the lubrication requirements of ball bearings. While the title limits the scope of the pamphlet, much of the information conveyed is no doubt applicable to ball bearings of all types. The general objects of lubrication of ball bearings are discussed and it is stated that the lubricant serves in reality four purposes. Instructions are given regarding the selection of both oils and greases for the lubrication of ball bearings, and considerable space with illustrations is devoted to various methods of supplying oil and feeding grease to the bearings.

Michigan Registrations

Michigan passenger car registrations during May totaled 8875, against 5116 in May of last year. Ford largely accounted for the gain over April, with a total of 3415. Chevrolet registered 2178 during May and Plymouth 1030, both showing a considerable gain over their April figures. Commercial vehicle registrations were 763 during May, against 595 in April.

Hudson-Essex Cut in Canada

Price reductions of $60 on all models of the Hudson line and $40 on all models of the Essex line sold in Canada have been announced by the Hudson Motor Car Co. of Canada, Ltd.

New Development in Electrical Transmission

The principle employed in radio transmission of having different stations send out electric waves of different frequencies and attuning the receiving set to the frequency of the station whose program it is desired to receive, is now being made use of also in electrical transmission lines. The frequency usually employed in alternating current transmission lines is 60 cycles per second. An entirely separate current, which may be used, for instance, for cutting in and out certain equipment on the line at definite periods of the day, may be sent over the same circuit.

Show Space Reduced in Price

M.E.M.A. - N.S.P.A. Event Blanks Go Out June 25

Following the meeting of the M.E.M.A.-N.S.P.A. Joint Show Operating Committee in Detroit on June 2, it is announced that the cost per square foot for exhibition space at the joint show, to be held in Detroit, Dec. 5 to 10, will be reduced from the usual $1 per square foot of previous years to 75 cents.

Space application blanks will be mailed to all manufacturer members of both associations about June 25. These will be mailed from the Chicago office of A. B. Coffman, who has been reappointed manager of this year's show, following his successful handling of all details in connection with the 1931 show in Atlantic City.

Allotment of show space will be made at two drawings to be held in Detroit on Sept. 22. Companies whose space applications, accompanied by remittances, are received by the show manager by midnight, Aug. 15, will be included in the first drawing, and those received after that time will be included in the second drawing.

In addition to admission regulations already announced, it is announced that the members of other automotive associations, as well as car factory and U. S. Government executives and officials, will be invited to visit the show during one of the last three days, the first three days being closed to all but those connected with member organizations of the M.E.M.A., N.S.P.A. or M.E.W.A.

Develops Fan for Heaters

A vacuum fan motor, operated by the vacuum in the inlet manifold and designed to circulate air through a hot-water heating coil in closed cars, has been developed by the Delta Corp. of Detroit. The motor is of the centrifugal or turbine type and is said to drive the fan at about the same speed as an electric motor at car speeds of 45 m.p.h. At speeds below 35 m.p.h. the vacuum motor is said to drive the fan even faster than an electric motor. An obvious advantage of this type of fan is that it does not drain the storage battery.

Offers Replacement Coils

Manhattan Insulated Wire Co., New York, has placed on the market the Manhattan high-tension supercoil, which is inclosed in an outer casing that is soldered and hermetically sealed. These coils are made in three sizes, to fit practically all cars in use.

Automobile Financing, April, 1932 Compared with Preceding Months

WASHINGTON, June 8—Monthly statistics on automobile financing, based on data reported to the Bureau of the Census by 345 automobile financing organizations, are presented in the table below.

These figures include complete revisions to date.

	1931	1932		Totals 4 Months (Jan.-April)	
	April	March*	April†	1931	1932
Wholesale Financing:					
Volume in dollars	$71,194,340	$34,121,364	$33,905,947	$224,261,690	$136,147,459
Retail Financing:					
Total—					
Number of cars	290,076	140,779	‡155,743	860,797	542,074
Total amount	$112,982,254	$51,148,285	$56,428,220	$332,801,495	$196,836,264
Average per car	389	363	362	387	363
New cars—					
Number of cars	133,347	46,234	57,665	362,110	186,026
Total amount	$70,544,761	$26,887,515	$31,838,007	$195,366,863	$105,743,302
Average per car	529	582	552	540	569
Used cars—					
Number of cars	149,112	90,121	93,446	475,953	339,310
Total amount	$39,546,288	$22,779,892	$23,076,622	$129,178,282	$85,644,326
Average per car	265	253	247	271	252
Unclassified—					
Number of cars	7,617	4,424	4,632	22,734	16,738
Total amount	$2,891,205	$1,480,878	$1,513,591	$8,256,350	$5,448,636
Average per car	380	335	327	363	326

* Revised.
† Preliminary.
‡ Of this number 37.03 per cent were new cars, 60.0 per cent used cars, and 2.97 per cent unclassified.

Willys Directors Fail to Meet

TOLEDO, June 8—Failure of directors of the Willys-Overland Co. to meet this week, according to the usual schedule, indicates that no action will be taken on the preferred dividend due July 1. If this is the case, control of the company will automatically revert to the preferred stockholders, of whom John N. Willys is one of the principals. Mr. Willys is expected to sail in a few days from Europe, to take up active direction of Willys-Overland affairs, according to advices here.

Valspar Leaves Canada

WALKERVILLE, ONT., June 6—The board of directors of the Valspar Corp. of Canada, Ltd., this city, has decided that all operations of the corporation in Canada will cease as on June 30.

Centers in Cleveland Plant

Gear Processing Co. has moved its Detroit operations to the home office in Cleveland, where its laboratories and plants are located at 6700 Grant Ave.

National Air Tour Suspended

The National Air Tour will not be conducted this year, according to officials in charge of the event.

Pegs Commodities To Aid Sales

CHICAGO, June 8—Minneapolis Moline Power Implement Co. has made available to purchasers of power machinery and farm implements three purchase plans which guarantee wheat price of 70 cents a bushel, corn price of 50 cents and cotton price of 8½ cents a pound. The plans may be applied to all purchases of $300 or over. An additional feature of the plan is a ten per cent discount on cash orders provided price of the commodity chosen for the day payment is to be made is less than the price stated in the guarantee. The discount also applies to 1932 and 1933 notes.

Bendix Earns $26,364 in Quarter

CHICAGO, June 8—Bendix Aviation Corp. reports net income after charges but before Federal taxes of $26,364 for the quarter ended March 31, against approximately $798,000 after charges and taxes including non-recurring profit of $221,000 in the first 1931 quarter. It was announced previously that the company would discontinue issuance of quarterly income statements.

Firestone on Committee

Harvey S. Firestone, Sr., chairman of the board of Firestone Tire & Rubber Co., has been named Akron representative on a committee in the Fourth Federal Reserve bank district to devise means of freeing credit and to study methods of providing more employment.

De Lisser Takes Dodge

De Lisser Motors, Inc., for several years one of the outstanding Ford dealerships in New York, has joined the dealer organization of Dodge Motors New York, Inc., handling Dodge and Plymouth cars.

Alloy Steel Mills Use Differential

Tonnage Buyers Are Reported Satisfied With New System

NEW YORK, June 9—Automotive alloy steel specialists are planning to follow the example of makers of cold-finished steel bars who recently have introduced a new set of quantity differentials.

At present only the buyer of less than 2000 lb. of alloy steel bars pays a quantity differential and this has been found inadequate as a means of minimizing small lot buying.

Tonnage buyers appear to be well satisfied with the new quantity differentials on cold-finished steel bars because they afford a certain amount of protection for themselves as against the small lot buyer, and little opposition to a similar revision of alloy steel bar quantity differentials is anticipated from representative consumers.

In hot-rolled strip steel a single base price is superseding the dual system that has been in vogue for the last few years. Heretofore widths 6-in. and under were in one price bracket and over 6-in. up to 24-in. in the second. The former have been quoted at 1.50 @ 1.60 cents, Pittsburgh, and the latter at 1.40 @ 1.50 cents. A single base price of 1.50 cents, Pittsburgh, is to replace the two quotations for third quarter. A new list of extras on hot rolled steel flats under ¼ in. thick has been issued in connection with the change.

There is still talk of an upward revision in prices of some sheet descriptions, full-finished automobile sheets coming in for special mention in this connection. Here and there one hears a plan discussed by which automobile sheets would be superseded as a description by full cold rolled sheets. So far the supposed $2 per ton advance for third quarter semi-finished steel commitments has not been tested and it remains to be seen whether it will hold. Third quarter prices for manufacturers' wire, which is moving in fairly large quantities into automotive consumption, have been reaffirmed on the old basis.

Pig Iron—Several 500 ton contracts from automotive foundries overhang the Cleveland market where No. 2 foundry and malleable are now quotable at $14.50@$15, furnace, for outside shipment.

Aluminum—Lower prices on secondary metal are noted, 98@99% remelt metal being offered at as low as 16c and secondary No. 12 alloy at 7@8c.

Copper—The only effect so far of the passage of the tax bill which includes an import duty of 4c per pound on copper has been to stimulate the hope of producers that higher price levels will be established before long. The disturbances in Chile, the second largest copper producing country of the world, where Anaconda and Kennecott own extensive properties, have also been without influence on the market.

Tin—The failure of one of the largest tin trading houses in London caused a suspension of trading on the London Metal Exchange on Monday.

S. A. E. to Settle Rating Controversy

Summer Meeting Session to End Puzzling Battle of Varied Opinions

(Continued from page 855)

formulas, and the truck rating formulas will give them ample opportunity to have a good time. A point not to be overlooked is the fact that those who favor one formula, those who favor a second and those who favor a third, or even a fourth, all favor rating by formula. For contrast it may be recalled that at the start of the committee's work there were many who doubted that any majority would ever agree upon any method of rating.

Formula rating, either of grade ability with a separate speed figure or an inclusive figure as proposed by Horine, leaves nothing to individual judgment. The answer is calculated from known facts. There is room for individual judgment in the manufacturer's figure for vehicle gross weight as A. G. Hereshoff, Dodge, points out. "The manufacturer in specifying the largest tire size has committed himself in the eyes of the operator to the maximum gross weight the vehicle can haul. * * * As long as engineers are capable of exercising independent judgment, there will be differences in their product. * * * This is not a matter of rating but rather a question of policy for the manufacturer to decide according to his conception of what is right and equitable and has no bearing whatsoever on the official rating."

With manufacturers given some freedom to decide and the engineers and slide rule experts in a cooperative mood the conference in Room C of the hotel at White Sulphur Springs may bring forth a noteworthy decision.

Montreal Aircraft Buys Curtiss-Reid

MONTREAL, June 4—Shareholders of the Curtiss-Reid Co., at a special general meeting held this afternoon, approved of the sale of the company to a new company which will be known as Montreal Aircraft Industries, Ltd., capitalized with 52,500 shares of no par value common stock. Curtiss-Reid preferred shareholders will receive share-for-share in the exchange, while the common shareholders will receive one new share for each 40 shares of Curtiss-Reid Co.

Mack Trucks Declares 25c Quarterly Dividend

At a meeting of the directors of Mack Trucks, Inc., held June 7, a quarterly dividend of 25 cents a share was declared on the stock of the company.

It was the belief of the directors that despite the fact that the company is making no current earnings at the present time, that with a surplus in excess of $16,000,000, accumulated from past earnings, and with cash and government bonds of approximately $8,000,000, and net quick assets of approximately $30,000,000, it would be unjust to the stockholders not to make this modest distribution.

May Output Estimated at 185,970 Units

NEW YORK, June 8—A 20 per cent increase in automobile production for May was reported today at the meeting of the directors of the National Automobile Chamber of Commerce.

Production of passenger cars and trucks for the month was estimated at 185,970 units which was an increase of 20 per cent in the output for the preceding month and was 44 per cent under production for May, 1931.

The output for the first five months of this year, according to the report, was 714,040 units, 48 per cent under the output for the same period last year.

Ford Output 72,000 in May in World Plants

DETROIT, June 6—World production of Ford cars and trucks in May aggregated 72,140 units, and Ford employment in the United States was increased by 25,000, according to a statement by the Ford Motor Co. June production will reach 112,160 units, according to present schedules.

All the 32 domestic Ford assembly branches in the United States are now in production, it was said, as well as the Ford Motor Co. of Canada, Limited, East Windsor, Ont., and its four assembly branches, and the Ford plants at Paris, France, Dagenham, England, and Copenhagen, Denmark.

Within a week other foreign plants at Antwerp, Belgium; Barcelona, Spain; Cologne, Germany; Istanboul, Turkey, and Yokohama, Japan, will be in production. Before the end of June other assembly branches at Sao Paulo, Brazil, and Buenos Aires, Argentina, will also be producing the new Fords.

Employment is gradually being increased as production is stepped up and former employees are called back. In May an average of 400 employees were called back to work at Dearborn each working day of the month. The June employment increase has begun at 500 a day. The increase in employment both at Ford plants and in the factories of suppliers is believed to have been a considerable factor in industrial activity generally during May.

April Aero Exports

During the month of April U. S. manufacturers exported 8 aircraft valued at $67,250 and 22 aircraft engines valued at $74,739. Exports of parachutes and parts were valued at $113,433, and of aircraft parts and accessories (except tires) at $83,958, according to the Bureau of Foreign and Domestic Commerce.

Prices Cut in Auburn Drive

Models Dropped Into Low-Price Field; Delivered Figures are Advertised

AUBURN, June 8—Slashing price reductions ranging from $270 to $620 have just been announced on all Auburn models. The standard eight coupe is now listed at $675, thus bringing Auburn into competition in the low priced field.

"This is not a 'sale' of obsolete merchandise," the factory announces: "It is Auburn's new basis for doing business."

The reductions are being announced to the public by factory-sponsored advertising campaigns featuring only delivered prices in various cities throughout the country.

Emphasis is being placed on delivered price and the "no-more-to-pay" idea in all the copy.

Following is a comparison of the old and new list prices:

Model	New List Price	Old List Price	Net Reduction
8-100 Standard			
Coupe	$675	$945	$270
Brougham	725	995	270
Sedan	775	1,045	270
Cabriolet	795	1,095	300
Phaeton	845	1,195	350
Speedster	845	1,195	350
7-pass. sedan	875	1,245	370
8-100 A Custom			
Coupe	$805	$1,145	$340
Brougham	855	1,195	340
Sedan	905	1,245	340
Cabriolet	925	1,295	370
Phaeton	975	1,395	420
Speedster	975	1,395	420
7-pass. sedan	1,005	1,445	440
12-160 Standard			
Coupe	$975	$1,445	$470
Brougham	1,025	1,495	470
Sedan	1,075	1,545	470
Cabriolet	1,095	1,595	500
Phaeton	1,145	1,695	550
Speedster	1,145	1,695	550
12-160 A Custom			
Coupe	$1,105	$1,645	$540
Brougham	1,155	1,695	540
Sedan	1,205	1,745	540
Cabriolet	1,225	1,795	570
Phaeton	1,275	1,895	620
Speedster	1,275	1,895	620

Curtiss, Ruthenburg Speak At Tool Engineers Meeting

A meeting of the American Society of Tool Engineers, Inc., was held June 9, at the Detroit-Leland Hotel. Frank Curtis, research engineer, Kearney & Trecker Corp., Milwaukee, spoke on "What Tool Engineers Should Know About Tungsten Carbide."

Louis Ruthenburg, president, Copeland Products, Inc., discussed "The Relation of the Tool Engineer to Management."

G. M. Names Connelly

E. F. Connelly has been chosen as manager of the General Motors Management Service of Canada, Ltd. Mr. Connelly will be in charge of the motor accounting system of all dealers in Canada.

Ford Takes 50% In Wayne Co.

Sales of all Makes in May Gain 98% Over April

DETROIT, June 6—With Ford accounting for more than 50 per cent of passenger car and commercial vehicle registrations, Wayne County sales for May showed a gain of 98 per cent over April for passenger cars and 18 per cent for trucks. Passenger car registrations as compared with May last year, however, are still off 27 per cent and trucks are off 54 per cent.

With Ford's 1306 fours and 1241 V-8's for May eliminated, the industry shows a gain over April of 9 per cent, while the decrease over May last year is 39 per cent. Aside from the low-priced field in which Ford, Chevrolet and Plymouth all registered substantial gains over April, conditions are rather spotty. Ford returned to first place of course this month, with Chevrolet second and Plymouth third. Pontiac, also showing a gain, is in fourth place. Other cars showing increases over May, 1931, include DeSoto, Lincoln, Nash, Pierce-Arrow, Reo and the Studebaker group, thanks to the Rockne.

The following makes showed gains over April: Ford, Chevrolet, Graham, Lincoln, Plymouth, Rockne and Willys-Overland. For the year to date, the following makes have registered more sales than during the corresponding period of last year: DeSoto, Graham, Hupmobile, Lincoln, Packard, Pierce-Arrow, Plymouth, Reo and the Studebaker group, which includes the Rockne this year.

Total passenger car registrations in May were 5059, as against 2557 in April and 6983 in May, 1931. Commercial car registrations totaled 256, as compared with 217 in April and 559 in May last year.

Buys Kissel Parts

MILWAUKEE, June 6—Kissel automobile owners are being advised by the Stephens Service Co., Freeport, Ill., that it has purchased the entire parts business and transferred it from the Kissel factory at Hartford, Wis., to its own warehouses at Freeport, from which orders will hereafter be filled. The service covers not only Kissel passenger cars but Kissel trucks, funeral cars, hearses, taxicabs, etc.

Allbestos Has New Line

PHILADELPHIA, June 8—Allbestos Corp. is installing a group of machines that will enable it to produce what is said to be an entirely new type brake lining.

Dominion Shows Cars

LEASIDE, ONT., June 6—New models produced by Dominion Motors, Ltd., were shown at the plant last week. Two Frontenacs, including the special sedan, sold at $1,295, in Toronto, and the custom sedan, priced at $1,385, are termed 1933 models. The bodies of these cars were designed by M. Comte Alixis de Sakhnoffsky.

Two Reo cars, which are being manufactured by Dominion Motors, include the standard sedan, and special sedan, which sell at from $1,700 to $1,800.

Planning New "Condor" 15-Passenger Biplane

ST. LOUIS, June 6—Plans for a new transport plane to replace the 18-passenger "Condor" are being completed by the Curtiss-Wright Airplane Co., which will begin production of the new ship late in the year.

The new transport is a biplane like the Condor, powered with two engines. There will be accommodations for 15 passengers. Other details of the ship are being withheld for the present, but Curtiss engineers state that they expect the plane to cruise 25 miles an hour faster than any multi-engined ship now in service.

One of the first airline executives to view the design of the proposed ship was Harold Elliott, general manager of Eastern Air Transport. Elliott, accompanied by three of his technical experts, visited the Curtiss-Wright plant last week. He stated that Eastern Air Transport is experiencing good passenger business and, as a result, will require additional equipment late in the year.

Canadian G. M. Promotes Everson

OSHAWA, ONT., June 4—E. A. Everson has been appointed assistant general sales manager of General Motors Products of Canada, Ltd., this city.

He has been manager of Montreal zone of General Motors Products since 1930. He began his automotive career in Oshawa in 1916 and has been with General Motors continuously since. As a school boy he saw the first automobile engines set up at the McLaughlin Motor Car Company factory in Oshawa and used to ride about the streets and countryside on many of the old "Skeleton" test jobs. Mr. Everson will be assistant to C. E. McTavish, general sales manager, and will be associated with Geo. E. Ansley, also assistant to the general sales manager.

B. V. Keller Named

Bruce V. Keller has been appointed advertising manager of Aluminum Industries, Inc., Cincinnati. Mr. Keller succeeds R. C. Glandorf, who has been transferred to the Chicago district as assistant to O. E. Van Altena, district manager. Mr. Keller goes to Aluminum Industries from the Timken Roller Bearing Co., where he served eight years as assistant advertising manager.

Business in Brief

Written by the Guaranty Trust Co., New York, exclusively for Automotive Industries

NEW YORK, June 8—General trade last week remained dull despite a moderate improvement here and there. Weather conditions on the whole have been favorable for retail trade. In the East, the retail movement has improved slightly in preparation for the summer; but wholesalers continue to supply only immediate wants. The better prospects for a settlement of the Government's finances and the strengthened tone of the security markets in the last few days have improved business sentiment.

CAR LOADINGS

The level of freight traffic carried by the railroads continues disappointing. Railway freight loadings during the week ended May 21 totaled 515,450 cars, which marks a decrease of 2217 cars below those during the preceding week, a decrease of 239,288 cars below those a year ago, and a decrease of 414,456 cars below those two years ago.

FARM PRICES

The index of prices of farm products on May 15 stood at 56 per cent of the pre-war level, as against 59 per cent a month earlier and 86 per cent a year earlier. The sharpest drop was reported in meat animals; the index for this class of farm products on May 15 was 59 per cent, as against 66 per cent a month earlier.

CONSTRUCTION AWARDS

Construction contracts awarded in 37 Eastern States during May, according to the F. W. Dodge Corporation, amounted to $146,221,200, as against $121,704,800 during the preceding month and $306,079,100 a year ago.

FISHER'S INDEX

Professor Fisher's index of wholesale commodity prices for the week ended June 4 stood at 60.2, as against 60.2 the week before and 61.1 two weeks before.

BANK DEBITS

Bank debits to individual accounts outside of New York City during the week ended June 1 were 40 per cent below those a year ago.

STOCK MARKET

Severe pressure continued on the stock market during the first part of last week. On Thursday the trend of the market was reversed, and the recovery continued through the half-day session on Saturday. The upward movement was also shared by the bond market, and one index of bond prices gained almost half of the loss sustained in the 33 days preceding the upward spurt. The complete reversal of the trend of security markets is attributed to the progress made in Congress toward enacting legislation to balance the budget and the announcement of the formation of a huge corporation, supported by the banks, for the purpose of acquiring sound investments in the security markets.

RESERVE STATEMENT

The consolidated statement of the Federal Reserve banks for the week ended June 1 showed increases of $24,000,000 in holdings of discounted bills and of $50,000,000 in holdings of Government securities. Holdings of bills bought in the open market decreased $3,000,000. The reserve ratio on June 1 stood at 61.4, as against 63.1 a week earlier and 64.1 two weeks earlier.

Chalmers, Pioneer Car Builder Dies in Beacon; Retired in 1922

Hugh Chalmers, who for more than a decade was one of the foremost executives in the automobile industry, died at a private hospital in Beacon, N. Y., on June 2, as a result of pneumonia contracted while on an automobile trip from Detroit to Yonkers, N. Y. He was president of the Chalmers Motor Co., Detroit, from 1908 to 1922.

Mr. Chalmers was born in Dayton, Ohio, on Oct. 3, 1873, and was therefore 58 years old at the time of his death. His first business connection was with the National Cash Register Co. of his native city, whose employ he entered as office boy at the age of 14. When 18 years of age he was made a salesman, and in this capacity he developed such talent that he was made district sales manager for the State of Ohio when only 22 years old. This success was followed five years later by his appointment as vice-president and general manager of the company. The National Cash Register Co. was then one of the leading exponents of advanced sales technique and it also stood out as a pioneer in welfare work among employees. Chalmers undoubtedly was a man of unusual sales and executive ability, and when he resigned from the company in 1907 it was reported that he had been drawing a salary of $72,000 a year, which was probably a record for that period.

Chalmers then became interested in the rapidly growing automobile industry and moved from Dayton to Detroit. There he bought an interest in the Thomas-Detroit Motor Co., which was organized by a number of men who previously had been connected with the Olds Motor Works of Detroit in different capacities, with the financial backing of E. R. Thomas, a Buffalo automobile manufacturer and capitalist. The original Thomas-Detroit car sold at $2,750 and was therefore in the high-priced class. This limited its sales, and a lowering in cost and sales price was made particularly necessary by the depression which started in the fall of 1907. In November, 1908, Chalmers secured control of the company and became its president. The corporate name was then changed to Chalmers-Detroit Motor Co., and later it was shortened to Chalmers Motor Co.

To meet the demands of the times, the Chalmers Motor Co. in 1909 brought out a medium-priced car, known as the Chalmers 30, which had a number of advanced features and sold at $1,500. It was the first American four-cylinder car which had all of the cylinders cast in a single block. This car met with a large sale, and it was continued and improved upon for a number of years, being later known as the Chalmers 40. For the manufacture of these cars the Chalmers Motor Co. built an immense factory on Jefferson Avenue, Detroit. Many of the manufacturers in those days, when the demand for automobiles grew by leaps and bounds, resorted to the practice of having most of their parts made outside, confining their own activities largely to assembling operations, but Chalmers was strong for manufacturing every part in his own plant.

Hugh Chalmers
1873-1932

When the Chalmers Motor Co. was well under way, toward the end of 1909, some of Chalmers' associates organized the Hudson Motor Car Co. to build a small, 20-hp. car, the Hudson, and Chalmers himself took an interest in the undertaking.

As president of the Chalmers Motor Co. Hugh Chalmers took an active part in the general activities of the industry, and during the war period he represented the National Automobile Chamber of Commerce in its dealings with the War Industries Board. To manufacture anti-aircraft guns for the Government he organized the Chalkis Company.

During the years following the war the star of the Chalmers Motor Co. gradually declined. Some of the models put out by it had been underpowered or suffered from other shortcomings, and following the slump of 1921, activities in the vast works on Jefferson Avenue were at a low ebb. In 1922 Mr. Chalmers retired from the company, and some time later it passed under the control of Walter P. Chrysler.

Mr. Chalmers is survived by his widow and by two sons and two daughters.

Motorists to Pay ¼ of Federal Tax

President Signs Act Which Will Collect $275,000,000 From Owners

(Continued from page 857)

Senator Bulkley of Ohio has inserted in the *Congressional Record* interesting tables showing the effect on dealers' business of the tire and tube taxes. This table (see page 857) reveals a tax as high as $1.95 on 3 x 7 10-ply first line tires, representing 6.08 per cent of the dealer's purchase price.

In some cases the ratio runs up to 8.33 per cent. On a 32 x 5 6-ply first line tire the tax is estimated at 77c, or 6.75 per cent of the dealer's purchase price. On inner casings the taxes range from 8c to 37c, and on truck tires they run from $1.82 to $6.79.

Where a user is replacing all four tires the tax necessarily would be multiplied by four. The maximum on the foregoing basis for passenger cars would be $7.80 for tires, and $27.16 for truck tires, assuming no spares. To this would be added $1.48 for casings. These figures rather graphically show the significance of these taxes.

These are among the most obnoxious taxes in the entire bill. It is, however, loaded down with many discriminatory taxes. These are included in not only excise taxes but in income taxes, tariff taxes, etc. It is the belief of many that the bill was so laden with malice aforethought. The idea seems to be, according to those taking this view, that the Congress realized it had made a mess of its revenue bill.

It did not want to go all over its work. Time was too precious. And the slogan "Balance the budget" became extremely pressing. The idea of a general sales tax was a political bogey. Being something new and made the object of false propaganda as to its burdensome character upon the consumer, Congress was afraid of it, especially on the eve of a political campaign. That is to say, a majority of Congress was frightened at the idea.

Instead, many think it has put over a piece of patchwork which it realizes will have to be altered soon, probably at the next session of Congress, for by that time it will be realized some of the excessive income taxes have been assessed on mythical incomes, and that discriminatory excise taxes will not nearly realize what they are supposed to produce.

Angle Opens Office

Glenn D. Angle and Associates have established themselves as consultants in aeronautical and automotive engineering in Cincinnati, Ohio, with offices at Parkway and Jackson Street.

New B-K Power Brake System Designed for Heavy Vehicles and Tractor Trains

A "Super-Vacuum" power brake has been developed by the Bragg-Kliesrath Corp., subsidiary of the Bendix Aviation Corp. In a general way the system is similar to the conventional vacuum brake-booster, which has been manufactured by Bragg-Kliesrath for nearly a decade. In the latter system a considerable proportion of the total effort of brake application (of the order of one-third or one-fourth) was supplied by the driver pressing on the pedal. This has been changed in the super-vacuum system, in which only a very small proportion of the force of application is the direct result of pedal pressure.

In the past there has been a general impression that vacuum-operated brakes were suited only to the lighter commercial vehicles, and the new system is intended to correct this impression which, the manufacturers say, never had any foundation in fact. A comparative test made of the super-vacuum and an ordinary vacuum brake in stopping a loaded 5-ton truck from an initial speed of 20 m.p.h. gave the results shown below.

With the ordinary "vacuum-suspended" type of brake there is a slight lag in the application of the brake due to the slow movement of air from the valve to the cylinder. In the super-vacuum brake this is overcome by the use of a relay valve.

Super-vacuum power is built around the vacuum-suspended principle. On large, heavy jobs and on tractor-trailer installations the time lag between the moment the driver puts his foot on the brake pedal and that when the power cylinder applies the brakes is due to the slowness of a large volume of air traveling through 30 or 40 ft. of vacuum line to one side of the piston and to compression built up on the other side of the piston on account of its rapid movement. Similar factors operate during release of the brakes. Rapid brake operation is particularly important in the case of heavy vehicles.

The largest cylinder which can be readily installed on a vehicle has a diameter of approximately 10 in., and for convenience of installation and in order to distribute the power more evenly and cheaply, a dual installation is used, one vacuum cylinder being located on each side of the vehicle.

A large-capacity valve, called the "Super-X," has been designed for the new system, and is used with 1-in. tubing instead of the customary ¾-in. All fittings, ports and lines were similarly enlarged. The larger orifice on the compression side of the cylinder serves to maintain the normal degree of vacuum, eliminating any possible pressure. Hence the piston stroke is not retarded on that account. At the other end of the cylinder the fittings and tubing are similarly enlarged.

This Super-Vacuum power installation with dual cylinders, larger valves and special reserve tanks costs only about 20 per cent more than the ordinary vacuum power installation, according to the manufacturer.

As a safety factor, a vacuum reserve tank is incorporated in the hook-up. A high degree of vacuum is present in this tank whenever the engine is running, and, should the engine stall, a check valve cuts off the admission of air to the system. In this way several full power applications are available even after the engine has stopped, which is of particular importance if the engine should stall on a hill.

Comparison of Ordinary and "Super-Vacuum" Brakes Made by Bragg-Kliesrath

Type of Installation	Stopping Distance	Time Lag
Ordinary Vacuum-Suspended	35.2 ft.	.57 sec.
Super Vacuum Power	25.6 ft.	.05 sec.

Dodge Deliveries Up

DETROIT, June 6—Dodge retail deliveries for the week ending May 30 were 2.5 per cent ahead of deliveries during the previous week. Compared with 1931, deliveries for the week showed a 15.7 per cent increase.

Heinrich Kleyer

Heinrich Kleyer, founder and in recent years chairman of the board of the Adler Works, Co., Inc., formerly Heinrich Kleyer, Frankfort-on-Main, Germany, died recently at the age of 79. After having graduated from the technical college of his native city, Darmstadt, he made a trip to the United States to familiarize himself with the latest developments in the then infant bicycle industry, and upon his return to Germany in 1880 he established an agency for the sale of imported bicycles in Frankfort. Only three years later he began the manufacture of bicycles, and he achieved the distinction of becoming the leader in that branch of industry in Germany. In 1895 the firm was reorganized as a stock company; in 1898 the manufacture of typewriters was taken up, and a few years later the firm branched out into the manufacture of automobiles, which has since become its chief line of activity.

+ + CALENDAR OF COMING EVENTS + +

FOREIGN SHOWS

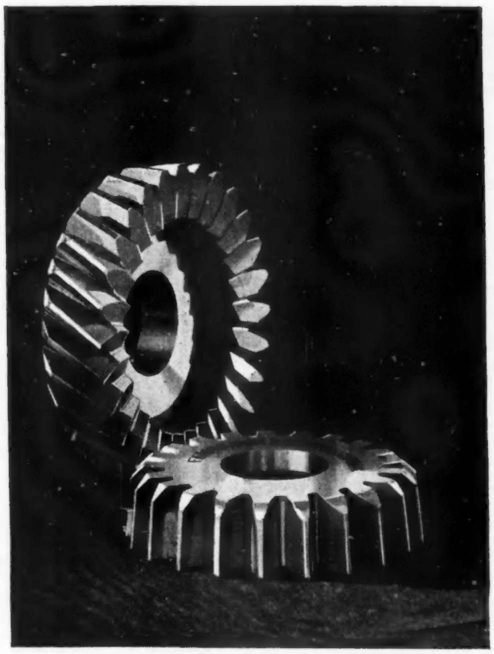
Bordeaux, Fair ....June
Cork, Commercial ....June
Inverness, Commercial..........June 21-24
Southampton, Commercial .....July 5- 9
Llandrindod, Wales, Commercial July 20-22
London, Olympia Show.........Oct. 13-22
Glasgow, Scottish Motor Show..Nov. 11-19

CONVENTIONS

American Soc. Mec. Eng. (Natl. Oil & Gas Meeting) State College, Pa. ....June 8-11
Soc. of Automotive Engineers, White Sulphur Springs (Summer Meeting) ....June 12-17
Associated Business Papers, Shawnee-on-Delaware .....June 18-19
Motor & Equipment Wholesalers Assn., Chicago ....June 20-24
American Society for Testing Materials, Atlantic City (Annual Meeting) ....June 20-24
Amer. Soc. Mechanical Engineers, Bigwin, Canada (Semi-Annual Meeting) ....June 27-30
Natl. Association of Taxicab Owners, Chicago ....July 7- 8
Natl. Team & Motor Truck Owners Assoc., Chicago (Annual) ....July 17-19
National Team & Motor Truck Owners Assn., Detroit ....July 17-19
American Chemical Society, Denver, Colo. ....Aug. 22-26
S.A.E. Aircraft Meeting, Cleveland ....Aug. 30-Sept. 1
American Society Mechanical Engineers, Cleveland, O. (Machine shop practice meeting) ....Sept. 12-17
American Trade Association Executives, Atlantic City (Annual) ....Sept. 15-17
Penna. Automotive Assn., Harrisburg, Pa. ....Sept. 19-20
Natl. Assoc. of Motor Bus Operators, Chicago ....Sept. 22-23
American Electric Railway Assn., Chicago, Ill. ....Sept. 22-23
Amer. Institute Mining & Met. Engrs. (Petroleum Division), Dallas, Texas ....Sept. 30-Oct. 1
Amer. Society for Steel Treating, Buffalo ....Oct. 3
Amer. Institute Mining & Met. Engrs. (Iron & Steel Division), Buffalo, N. Y. ....Oct. 3-6
National Safety Council, Washington, D. C. ....Oct. 3- 7
American Welding Society, Buffalo, N. Y. ....Oct. 3-7
American Society Mechanical Engineers, Buffalo, N. Y. (Natl. Iron and Steel Meeting)....Oct. 3- 8
S. A. E., Annual Transportation Meeting, Toronto ....Oct. 4- 6
American Gas Association, Atlantic City (Annual)............Oct. 10-14
Natl. Hardware Assn. (Accessories Branch), Atlantic City, N. J. ....Oct. 17-22
American Society Mechanical Engineers, New York City (Annual Meeting) ....Dec. 5- 9
Natl. Exposition of Power & Mechanical Engineering, New York ....Dec. 5-10

RACES

Altoona ....June 12
Roby, Ind. ....June 19
Altoona ....Sept. 5



"X"-Member Frames Are Six Times Stiffer

(Continued from page 846)

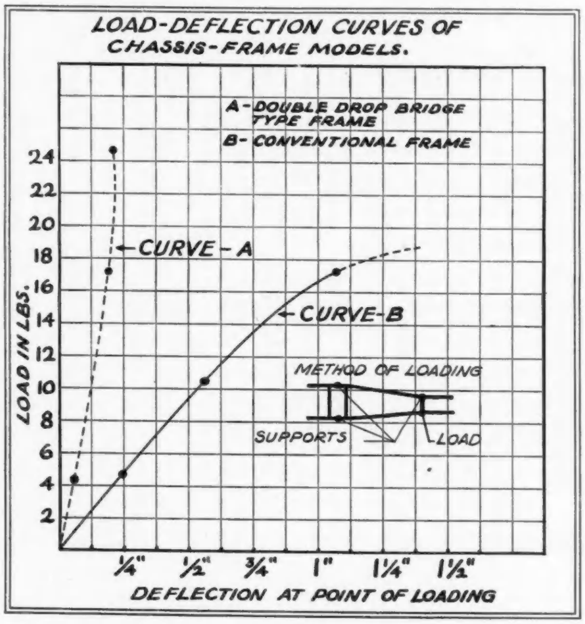


Fig. 3—Comparative load-deflection curves of the frames shown in Figs. 1 and 2

compromise in torsional rigidity. Again, it would be possible to compare a given frame design with competitive designs.

One other important relation which we were unable to check due to lack of facilities is a comparative measure of resistance to diagonal deflection such as might be imposed by faulty tracking, and wheel misalignment in general. This would be measured by setting the frame vertically in a compression-testing machine with one rail fixed—the other loaded. An alternative method which we expect to investigate is that of photoelasticity. This should give not only a qualitative measure of resistance but also indicate regions of severe stress and points of flexure.

Good qualitative results from model tests are made possible by the art of the welder. Here is an interesting commentary on the new and the old facilities. The frames in Figs. 1 and 2 were made for this investigation through the courtesy of the E. G. Budd Mfg. Co. The frame in Fig. 4 is from the collection of P. M. Heldt and represents an early effort. No doubt you will recognize it as a model of the Star chassis (with the million-dollar motor) which was described in *Automotive Industries*, July 27, 1922.

This frame is not accurately to scale due to the restrictions imposed by the use of eyelets for fastenings. Moreover, the principal cross-members have been omitted. But it does illustrate a specific design principle.

Its principal feature was a huge tubular member which served the dual role of muffler and stiffener. The model is so arranged that the tube can be disconnected at will by loosening the thumbscrew. When the tube is free, the frame is flexible; when fixed, the frame is rigid. However, the model does not lend itself to the formal test described above.

The stiffness imparted to the Star frame by its tubular member indicates the advantages from the rigidity standpoint of the tubular backbone frames used in Austria and Czechoslovakia. In the cars with this type of frame, a large diameter steel tube extends from the rear of the unit powerplant to the housing for the final drive gear and has outriggers welded or otherwise secured to it, on which the body is carried. All of these cars are provided with swinging axles and independently sprung wheels. The large diameter tube not only has great torsional stiffness but it also offers great resistance to bending stresses in proportion to its weight. This construction, of course, makes it more difficult to mount the various chassis units, but from the standpoint of a rigid and at the same time comparatively light support, the tubular frame seems to have much to commend it.

Recent correspondence with designing engineers shows that they are working actively on the problem of body-frame relationships. To comprehend the situation it is necessary to consider other matters quite outside the scope of this article. A case in point is the so-called torsional stabilizer ([2]) introduced by Hupp. Here is a device built right into the body structure. With the addition of only five or six pounds the requisite rigidity is attained at the front end, according to their chassis engineer.

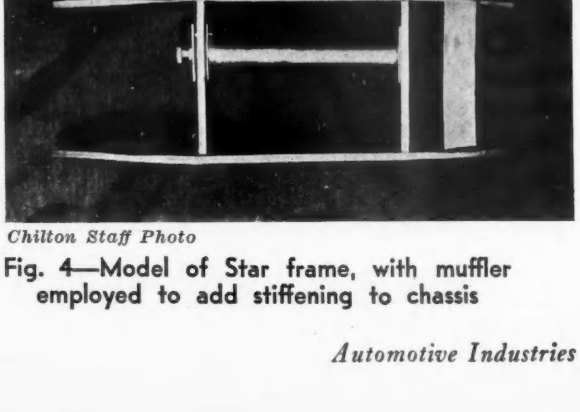
Naturally, the body structure is employed to impart additional rigidity to the complete unit. How much depends entirely upon the method of attachment to the chassis. One classic departure from conventional mounting was developed by E. G. Budd for the Victory Six, in which the body is sill-less, the side rails conform to the body contour, and body panels are drawn down the depth of the side rail and bolted through the neutral axis instead of bolting to outriggers or brackets.

This produces a wider frame, eliminates body overhang, and is said to have increased the rigidity of the entire unit to a marked degree. This same construction has been adopted for Chrysler cars.

Nevertheless, this feature does not relieve the engineer of the necessity of apportioning the deforming loads between the frame and body. Events have proved that the body must be freed of twisting strains so far as possible. And the advent of stiffer frames brings the problem closer to its solution.

It must not be inferred that an investigation such as this disposes of the mutual problems of the chassis and body engineers. But it does help settle the question of comparing the dynamic characteristics of structures which are difficult if not impossible to analyze on paper.

[2] "Trusses Stiffen Hupp Frame," by Athel Denham, *Automotive Industries*, Jan. 2, 1932.



Chilton Staff Photo

Fig. 4—Model of Star frame, with muffler employed to add stiffening to chassis


CLEAN STEEL

Let Engineering Rule At Indianapolis Race

(*Continued from page 841*)

Mr. Roos caught in an informal pose at his desk

I feel sure that these changes would be received with great interest by motor car manufacturers in general; that they would definitely serve to keep up the interest of passenger car factories in the race.

The public is more interested in the race because of the semi-stock car entries and many fans go to the race with a definite desire to root for a particular make of car.

The additional changes which I am suggesting are simply further amplifications of the constructive trend which the rule changes have been taking for several years back. Their adoption into the rules would merely intensify the benefits which have been accruing to and from the big race ever since removal of the 91 cu. in. restrictions brought the Indianapolis Race back from being an engineering duel between Fred Duesenberg and Harry Miller into the realm of general factory and public interest and participation.

For the rest, it seems to me, the Indianapolis Race rules might well remain much as they are. I am opposed to the suggestion that the weight per cu. in. be reduced from 7½ to 6½ lb. Keeping the higher figure will insure that the cars sent into the track will not be light flimsy structures with huge engines all out of proportion to the rest of the vehicle; it will help keep the race cars nearer to current engineering practice.

Admission of dual valves doesn't please me particularly, but since certain manufacturers actually use dual valves as standard on stock models, it is only fair that the rules should permit their use in the race.

The performance of the semi-stock models in the race just completed, the huge public interest manifested and the technical lessons which all of us are now engaged in learning from the results of this latest speed test all combine to prove the value and importance of the Indianapolis Race to be reaching new peaks every year. Motor car manufacturers showed more interest in the race this year than they have for some time. Incorporation of the rule changes suggested here would, I sincerely believe, further intensify that interest and participation in future years.

Atmospheric Pressure Operates Miller Brakes

AN interesting system of operating brakes by hydraulic suction has been invented by Robert Miller, New York, and we understand that a patent on it has been applied for. It differs from the usual hydraulic brake system in that the liquid, instead of being placed under pressure by pressing down on the brake pedal, is relieved of pressure, and the force which actually operates the brakes is the pressure of the atmosphere. The system is applied in two types, one operated directly by pedal pressure and the other through a vacuum booster.

In the application of the direct-actuated system the brake pedal is connected by a link to a diaphragm in the master chamber. At each wheel there is a brake chamber containing a diaphragm connected by a link to the brake arm. These individual brake chambers are connected to the master chamber by tubing.

With the direct-actuated type, when the brake pedal is pushed forward, it pulls on the master-chamber diaphragm, thereby drawing liquid out of the tubing and brake chambers. This motion of the liquid is followed up by the brake-chamber diaphragm on which the atmosphere presses with a pressure of 15 lb. per sq. in. This diaphragm operates the brake through the link connection.

When vacuum booster action is desired, the link to the master-chamber diaphragm is surrounded by an air-tight rubber boot and a slotted link connects a vacuum valve to the brake pedal. After the pedal has been moved a short distance, it opens the vacuum valve, thereby placing the master chamber in communication with the inlet manifold. The brakes are then applied by the inlet vacuum, and no great pressure on the pedal is required. It seems, however, that no means have been provided for modulating the braking effect of the inlet vacuum. When there is no vacuum in the inlet manifold, as when the engine is stalled, it is only necessary to press harder on the pedal to apply the brakes in the usual way.

Among the advantages claimed for this hydraulic suction system, as compared with the hydraulic pressure system, are that the presence of air in the system is not so serious, for a small amount of air will only slightly reduce the pressure which can be transmitted to the brakes, and this serves as a warning; and that bleeding is simpler, as the system comprises no sliding joints which may develop leaks.